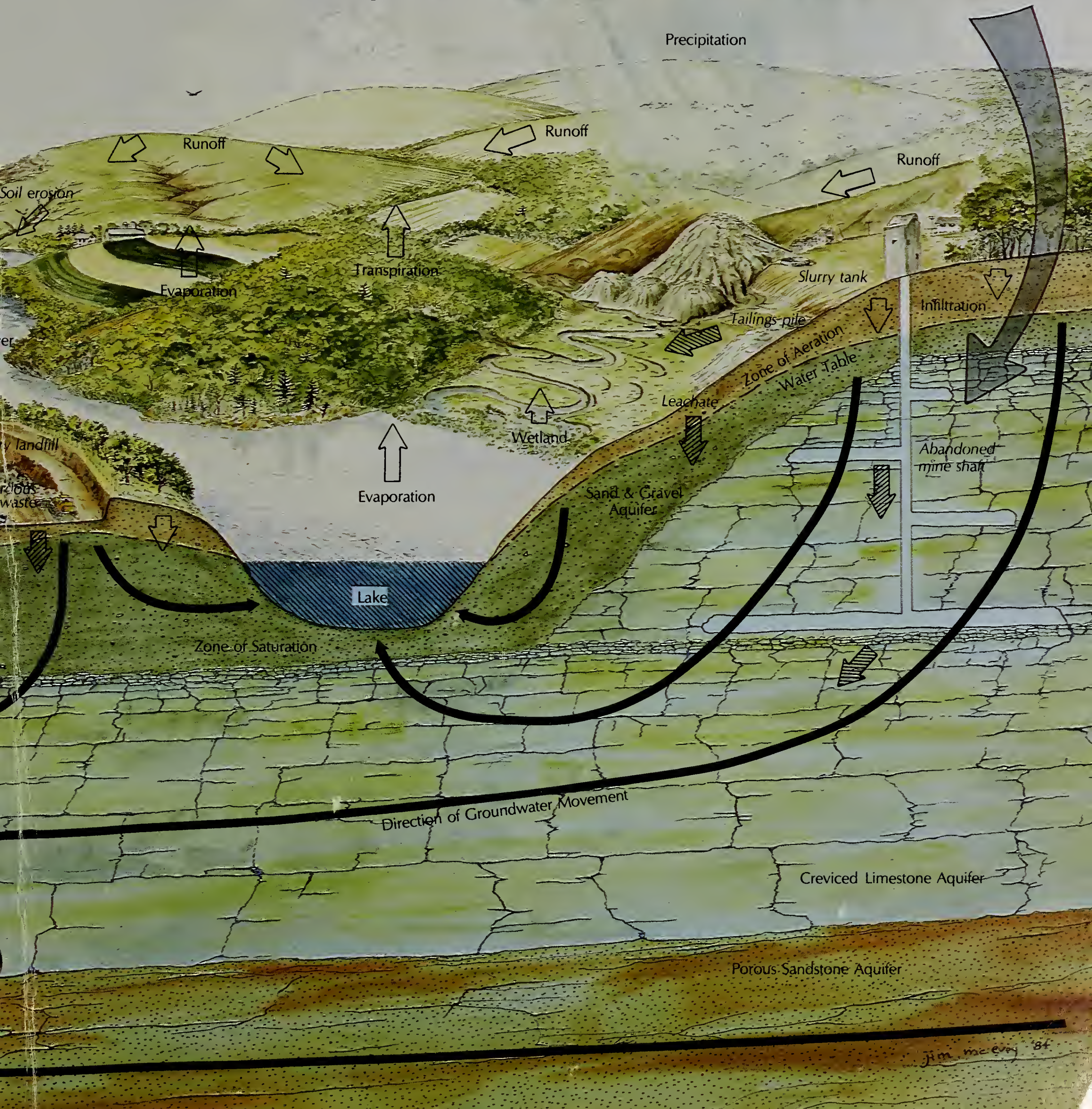
onal Nonpoint Conference

The Water Quality Act —
Making Nonpoint Programs Work

St. Louis, Missouri
April 23 - 26, 1989



United States Department of Agriculture

Soil Conservation Service

967272

April 23, 1989

To participants of the National Nonpoint Conference

This booklet of water quality information is the result of the efforts of many individuals from the Soil Conservation Service and other federal agencies and from academia and the agricultural chemical industry. We have included those subjects that we feel would be of most use to you as you work with our Nation's farmers and other land users to plan and install conservation practices.

The Soil Conservation Service is pleased to be a sponsor of this conference along with the National Association of Conservation Districts; the National Association of State Conservation Administrators; the U.S. Environmental Protection Agency; the Association of State and Interstate Water Pollution Control Administrators; the Conservation Technology Information Center; the National Association of State Departments of Agriculture; the North American Lake Management Society; and the Soil and Water Conservation Society.

It is with pleasure that I present materials representing such a broad base of technical and creative initiative. We are confident that you as a participant in this "National Nonpoint Conference: The Water Quality Act - Making Nonpoint Programs Work" will use these materials wisely in assisting individual landusers in private sector agriculture to address water quality and quantity concerns to strengthen the Nation's efforts to protect and enhance our water resources.

Wilson Scaling

WILSON SCALING
Chief
Soil Conservation Service

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Overview

Samples of water quality guides, references, and exhibits have been collected from water quality material that was developed by the U.S. Department of Agriculture, Soil Conservation Service. The water quality material has been provided to SCS State Offices in October and November 1988.to help states upgrade Field Office Technical Guides (FOTG). The information in this publication may be useful to some when working with projects that involve water quantity and quality.

States are using this information to integrate water quality and quantity considerations into the conservation planning process. Many of the documents may serve as references for conservation planners in SCS Field Offices and others.

Much of the material will be modified and localized. This will require the collection, interpretation, and assimilation of considerable resource information. The process of upgrading FOTG's is now under way and is being carried out by an interdisciplinary team composed of resource conservationists, soil scientist, engineers, agronomists, range conservationist, and others.

A summary of each sections of this publication follows:

Section I - Basic Concepts and Processes

A. Introduction to Nonpoint Sources of Contamination

B. USDA and SCS Water Quality Policies

Numerous state and local water quality policies, laws, regulations and ordinances influence SCS and District activities related to water quality. Summarized in this section are USDA Nonpoint Source Water Quality Policy, USDA Ground Water Quality policy, and SCS Water Quality Policy documents

C. Pollutant Movement and Basic Concepts and Processes

Three basic concept: (1) water budgets, (2) chemical budgets, and (3) the pollutant movement process - underlie most conservation planning for water quality. This section summarizes these concepts and processes and provides examples and illustration.

Research, studies, and data on local conditions may also be available and provide additional information on these concepts and processes.

D. Technical Information for Chemical Budgets

Soils interpretations and ratings have been expanded to evaluate hazards to ground and surface water in areas where land use and management may affect water resources.

Sample pages of a Pesticide Data Base is provided. The data base contains information on the characteristic of about 200 common agricultural pesticides used across the United States, representing over 70 percent of total pesticide use in the country. The tables contain the common name and some trade names. Tables

include the partitioning coefficient (Koc) based on organic carbon, the half-life of pesticides in soil, solubility of the pesticide in water, and other data.

This reference can be used with soils data to help determine the movement of specific pesticides in the environment. The partition coefficient indicates whether the pesticide is more likely to move with water (runoff and infiltration) or only with soil particles (sedimentation). The half-life indicates the length of time the pesticide will be of concern in the environment.

Soil ratings for nitrate leaching are also enclosed. These contain a rating for nitrate leaching potential for each soil series. This information is important to areas where aquifers are vulnerable to nitrate leaching. Where potential ground water nutrient problems exist and the soils have a high potential for leaching, nitrogen must be managed to reduce nitrate movement into to a aquifer.

Section II - Water Resource Information and Evaluation

A. Water Quality Criteria, Standards, and Use Classifications

Each state has establish water quality criteria, standards, and use classifications. Attached are examples from two states. These documents illustrate the concentration levels of water contaminants allowed for health and environmental protection.

B. Water Resource Maps

SCS State offices are assembling data, water resource maps, and reports related to ground and surface water. Data covers water quality and quantity, present and potential water uses, potential hazards to the state's water resources. Data is being developed first for areas where significant water resource concerns exist.

State water quality agencies, health departments, the U.S. Geological Survey and other state and federal agencies that have water related missions are being included in this effort. State offices are working with the State Water Quality Management Agencies (SWQMA) and other agencies and entities to interpret water resource data for field offices. In some states and some counties information will be scant.

Section III - Effects of Land Use, Management, and Conservation Practices on Water Resources

A. Effects of Land Use and Management on Water Resources

The tables in this section summarize from a national perspective the effects of land uses on water quality and quantity. Although many variations of these effects occur, the tables provide background information useful to field personnel who are helping land users.

B. Conservation Practice Standards

A list of all practices contained in the National Handbook of Conservation Practices is included in this section. National standards exist for all practices. Two examples for Subsurface Drains and Terraces are provided. A water resource

supplement for each conservation practice standard has been recently added and these are also attached.

These supplements discuss planning considerations for each practice with regard to water quality and quantity. The information in the supplements is based on current water quality and quantity research and on the experiences of SCS.

C. Guide to Selecting Conservation Practices

This section contains 16 tables that can be used as guides to selecting conservation practices on the basis of their likely effects on water quality, quantity, or both. Each table is directed toward a specific land use: Nonirrigated cropland, for example. States may tailor this information to local conditions and may add practices, land uses, or specific resource concerns that are appropriate to local conditions and delete those that are not.

D. Effects of conservation practices on water quality and quantity

The tables and text provide examples of the effects of conservation practices on water resources. A booklet of these effects has been produced and is available. Conservation practices may have different influences on water depending on differing soil conditions, climate, land uses, and management level.

The tables and text summarizes the expected or normal effects of each conservation practice. Site-specific conditions that may alter the effects should be documented.

Section IV - Planning Process

A. Field Office Technical Guides

Technical information supporting most activities carried out in the local Field Offices of SCS is contained in Field Office Technical Guides (FOTG's). The guides are the primary references about local soil, water, and related resource conditions.

This section identifies the five sections of the FOTG and the contents of each section.

B. Planning in Response to Water Quality Concerns

This section identifies the 10 steps of the planning process. It illustrates how the information contained in this handbook can be used to improve, restore, or maintain water resources.

Glossary Section

A glossary of technical terms used in this document is attached to aid the reader.

Section I – Basic Concepts and Processes

A. Introduction to Nonpoint Sources of Contamination

The term "Nonpoint Source" (NPS) was first used in the water pollution control legislation that was passed by Congress in the early 1970's. NPS applies to the following sources of pollution:

Agriculture	Urban runoff
Mining	Construction

As point source pollution was being corrected from municipal and industrial sources, the need for controlling pollutants in storm runoff from dispersed nonpoint sources became more apparent.

Lakes and streams are still adversely effected from sediment, nutrients, pesticides, animal waste, bacteria, and salts. Recent surveys are finding the presence of pesticides, and in some locations, high nitrogen concentrations are occurring in ground water. A renewed interest is occurring in controlling all NPS especially agricultural sources.

The state water quality agencies are presently assessing the surface and ground water resources to determine its quality and potential for pollution from NPS.

Plans are being developed to correct the pollution problems. Regulatory action will be considered in some NPS abatement plans.

USDA and Soil Conservation Service (SCS) recently issued policies (see policy section) that states a firm commitment to develop the necessary technology to provide technical assistance to farmers and ranchers on water quality. USDA wants to provide the best information possible to help the farmer and rancher to operate without causing surface or ground water pollution.

A task force was formed in 1988 to compile the latest information that states could use for improving technical guidance to the agricultural land user. This information was presented to the states during SCS and Extension Service workshops in October and November of 1988. The states are using this information and state soil and water resource information to develop technical guidance for SCS and Extension Service staffs at the county or Parish level. This information will be available to our field offices by early 1989.

SCS and Extension Service Staffs will provide training during the remainder of FY89. The objective is to be fully operational by October 1989 at the beginning of FY90.

SCS will begin to consider water quality in the development of conservation plans in 1990. Some areas are already incorporating water quality.

This document provides a summary of the workshop material. The information has been condensed and some excerpts of the technical material have been used for illustration.

B. USDA and SCS Water Quality Policies

The following information summarizes basic USDA policy that relate directly to water quality activities of SCS.

USDA Nonpoint Source WQ Policy, Dept. Reg. 9500-6, December 5, 1986

(SCS initiated this first Departmental policy on Water Quality.)

The Department will:

III	B9	Provide educational, technical, and other assistance to WQ efforts
III	B10	Use technical knowledge and base information to improve data gathering to assess WQ problems
III	B11	Conduct research on cause-effects of practices to WQ

Agencies of the Department of Agriculture will:

IV	C2	Coordinate WQ activities with others (fed, state, local)
IV	C3	Intergrate WQ activities into programs, technical assistance, and research
IV	C6	Train personnel on Surface and Ground Water WQ principles

USDA Policy for Ground Water Quality, Dept. Reg. 9500-7, November 9,1987

(The first Departmental policy dealing with Ground Water quality.)

The Department will work to:

Item	2	Improve management, coordination, and effectiveness fo assistance to farmers, ranchers, government agencies, etc.
Item	3	Protect GW from harmful substances and to enhance GW quality
	3a	Foster improvements in management of nutrients and use of chemicals
Item	4a	Support research and monitoring relative to GW
	4b	Provide information, education, and technical assistance to minimized the risks of GW contamination
Item	5b	Coordinate with federal, state, and others on the use fo nutrients and pesticides through technology transfer to protect ground water

SCS Water Quality Policy, General Manual 460, Part 401, April 1987

SCS WQ policy was established following the USDA NonPoint Source WQ Policy

It shall be SCS Policy to:

1.2	c	Coordinate WQ activities with others (all inclusive)
	e	Intergrate WQ concepts and techniques into all programs
	h	Support data gathering and research to assess WQ
	i	Develop environmental tools to quantify environmental and economic effects of conservation practices
	j	Train agency and district personnel in surface and GW quality concepts and techniques

The Water Quality responsibilities in SCS are assigned as follows:

401.3	a	Chief coordinates with other federal agencies and departments
401.3	b	Deputy Chief Programs intergrates WQ into all programs
	b	DC Prog provides guidance in implementing this policy
401.3	c	Deputy Chief Technology provides technology development, transfer, and training
	c	DC Tech develops/revises technical guides, manuals, etc.
401.3	d	Director Land Treatment Programs (LTP) provides leadership for WQ programs
	d	Director LTP encourages progress reporting for WQ tracking
401.3	e	Water Quality Coordinating Committee (WQCC) provides coordination of PROG and TECH divisions for WQ activities
401.3	f	National Technical Center (NTC) Directors provide WQ technical assistance to NHQ and states
	f	NTC Directors assures states have WQ technical capability to deliver WQ programs
401.3	g	State Conservationists (STC) revise manuals and technical guides to include WQ
	g	STC will maintain trained personnel in WQ
	g	STC will evaluate SCS-assisted WQ activities which includes monitoring and evaluation

C. Pollutant Movement and Basic Concepts Processes

An understanding of the following concepts and processes is necessary for effective Resource Management Systems planning:

A. Pollutant Movement

The movement of pollutants from agricultural lands is influenced by: (1) availability, (2) detachment, and (3) transport. Resource management systems can influence the water and chemical budgets by manipulating those factors:

1. Availability. Eliminate the pollutant from the site or adjust the quantity used or frequency of application to the level of actual need for consumption.

Example: Apply nitrate to pastures following soil test recommendations to minimize the movement of excess nitrogen below the root zone and into deep percolating water. Apply in increments over the growing season.

2. Detachment. Control the splash effect of rain or irrigation water striking the soil surface and the velocity and direction of runoff.

Pesticide companies are experimenting with additives that can be used with pesticides to reduce detachment of water-soluble pesticides. In the near future, these additives may be available to use where ground water contamination from pesticides is a concern.

Examples: Use vegetative cover, conservation tillage, or mulches to prevent detachment of soil particles by splash energy. Use strip cropping, field borders, or waterways to reduce soil particle detachment.

3. **Transport.** Intercept pollutants or reduce the transport capacity.

Examples: Slow or stop sediment or sediment-attached substances with terraces, vegetative filters, or sediment basins. Double crop to reduce soil moisture, which in turn reduces runoff, deep percolation, and chemical and sediment transport. Trap sediment and sediment-attached substances in wetlands.

These concepts and processes must be considered when resource management systems are developed. There is no easy-to-use calculation for evaluating net effects to ground or surface waters. Experience in using applicable conservation practices, combined with good judgement, must be used in combination with available data.

B. The Water Budget

The term "water budget" is routinely used in planning irrigation water application. Water budgets can also be used to evaluate the movement of water from all sources (precipitation or precipitation and irrigation). The water budget

is an accounting method that can be used to determine how soil-water-plant relationships influence the movement of water from a particular site, and hence potential routes of pollutant movement associated with water.

Planners of resource management systems must understand how these soil-water-plant relationships (fig. 1) can effect pollutant movement. All precipitation and irrigation waters are inputs to the water budget. All water inputs must either go to runoff or infiltration. Minor quantities of water evaporate from the soil surface during precipitation and irrigation. These losses have an insignificant effect and are not considered in this discussion.

When one part of the budget is changed, other parts of the budget will be affected. The following equations describe the water budget process:

Equation 1. Precipitation + Irrigation = Runoff + Infiltration

In the precipitation equation, the increase of precipitation, irrigation water or both, will increase the runoff, infiltration, or both.

All infiltrated water must go to either (1) soil storage, (2) plant transpiration, (3) evaporation, (4) interflow, or (5) deep percolation.

Equation 2. Infiltration = Soil Storage+ Plant Transpiration + Evaporation + Interflow + Deep Percolation

In the infiltration equation, the increase or reduction of water use or movement in any of the budget categories will affect the remaining ones.

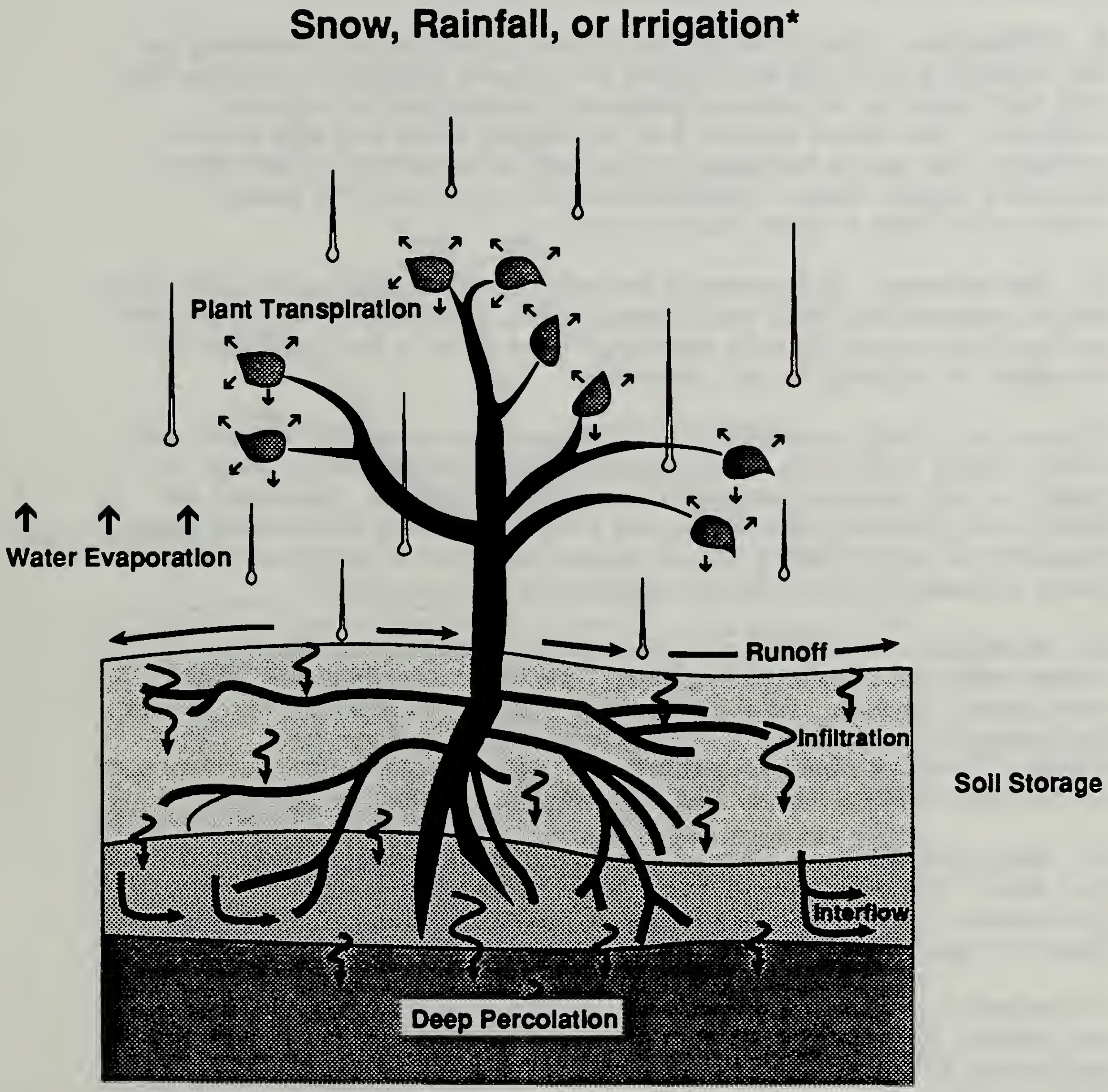
The movement of water can be reduced or redirected using conservation practices. Some of the influences of conservation practices on the water budget are described below.

1. Precipitation and irrigation. Precipitation is condensed water from the atmosphere which reaches the earth's surface in the form of rain, snow, hail, or sleet. Whereas the farmer, rancher, or planner can't manage the timing or rate of water from natural precipitation, he or she can control irrigation water. When too much irrigation water is applied, water is wasted and there is a potential for damage to water quality or quantity. The excess will run off, go into the interflow, or into deep percolation. Irrigation water management is important where the quality or quantity of water resources is a concern.

2. Runoff. Runoff is water that flows off an area. It occurs when the soil's water storage capacity is exceeded, or when the rate of precipitation or irrigation water applied is greater than the infiltration rate. Irrigation systems should be designed to match the infiltration rate of the soil to reduce runoff. Any farming practice that increases infiltration will reduce runoff.

3. Plant transpiration. Plant transpiration is the process in which plants give off waste matter and water through the leaves. Plants consume soil water from the root zone. The water taken from the soil may be stored in the plants or returned to the atmosphere by transpiration. During plant dormancy, (usually winter) however, plants do not remove soil water, and water inputs become available for soil storage, interflow, and deep percolation. Using winter cover crops, or plants that grow in what is considered the dormant season, can

Illustration of Soil - Plant - Water Relationship



*Irrigation applies to all application methods.

Figure 1

reduce water that would otherwise go into deep percolation or the interflow. In semiarid areas, some cropland is managed with a year of fallow in the rotation. The fallow year is for storing precipitation in the soil for the crops in the following year(s).

4. Water evaporation. Water evaporation is the process of turning water into vapor. Crop residue can be managed to reduce soil evaporation by reducing soil temperature, resisting wind movement at the soil surface, and protecting the soil from low-humidity moisture transfer.

5. Infiltration. This is the process of water going into, or permeating the soil. Increasing cover the soil's surface can increase infiltration. Practices that hold back water on the surface (contouring, for example) will increase infiltration. The volume of water that may be held in the root zone and the infiltration rate can be increased in most soils by improving the soil's tilth or increasing organic matter. Practices that can improve soil tilth include conservation tillage or green manure crops.

6. Soil storage. Soil storage is the soil's capacity to hold water. Soil survey reports estimate each soil's water storage ability. Some conservation practices can significantly alter the soil's capacity to store water in the tillage layer by increasing or reducing the soil density.

In some soils, tillage pans (fig.2) form and restrict the movement of water and roots. Figure 2 illustrates the soil-plant-water relationship with a tillage pan. A tillage pan will decrease deep percolation and soil storage. Decreased soil storage may decrease plant uptake and plant transpiration and increase runoff. Subsoiling or deep chiseling permits deeper movement of water and roots, hence increasing the soil storage capacity and reducing runoff.

7. Interflow. Interflow is subsurface water that moves laterally above an impermeable soil or geologic formation. The water may be used by plants, resurface as a seep or spring, or eventually reach a permeable material or void that permits it to continue its downward journey to the water table. If an excess of interflow water is a problem at a particular site, some practices, such as interceptor drains, can be used to manage the water.

8. Deep percolation. Deep percolation is the movement of water below the root zone. The water may go into interflow or recharge an aquifer. Most conservation practices cannot change the quality or quantity of water after it leaves the root zone and goes into deep percolation.

Conservation practices can be used to influence many parts of the water budget and redirect the water movement to reduce possible detrimental effects of agricultural activities. Each practice must be assessed for the effect it has on the water budget.

Illustration of Soil - Plant - Water Relationship With Tillage Pan

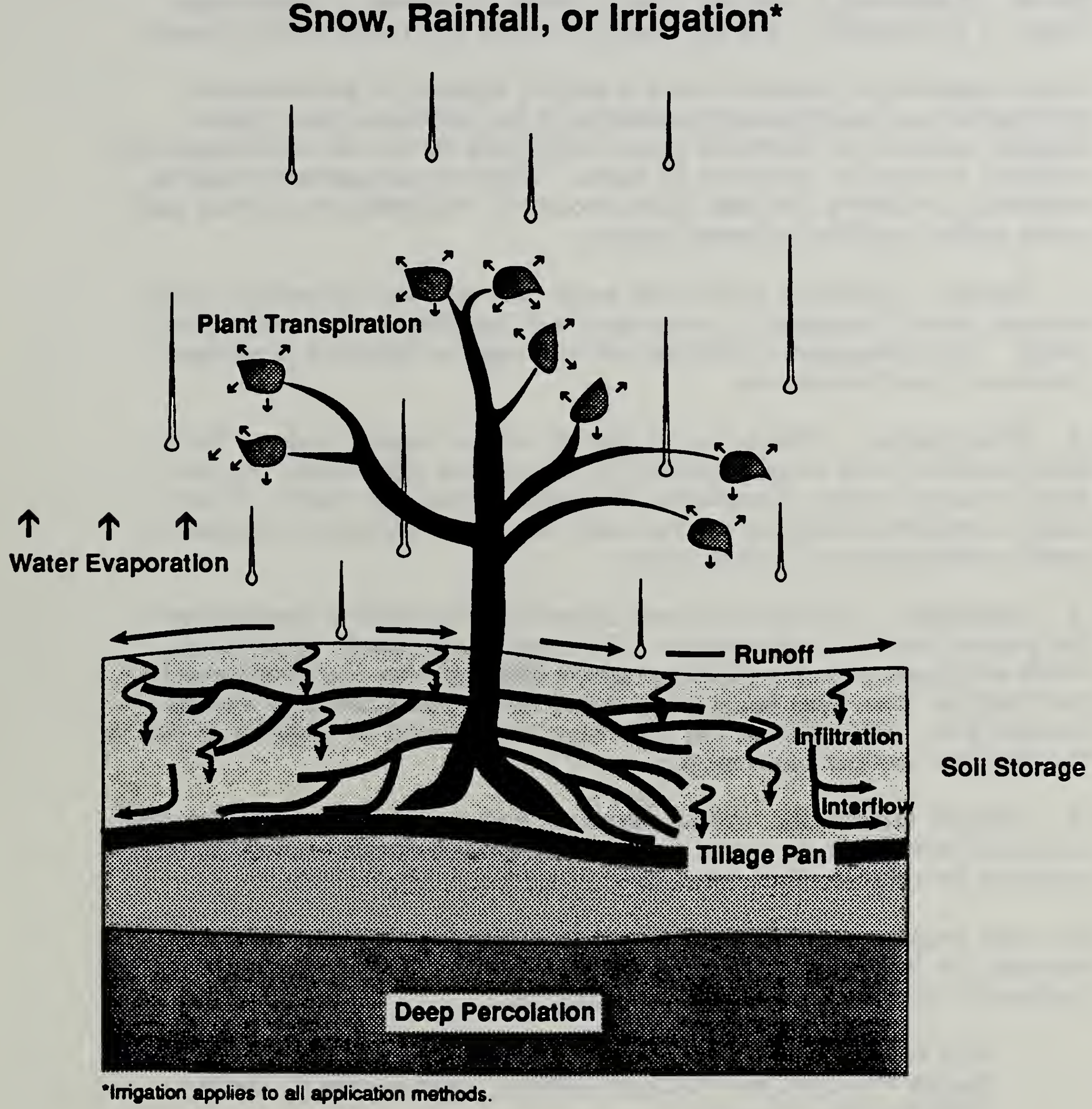


Figure 2

C. Chemical Budgets

Chemicals are essential to agricultural production in many locations and production systems. Users must be careful with chemical selection and application techniques to insure protection of the water resources.

When a chemical is applied it may be (1) consumed by plants, (2) volatilized into the air, (3) adsorbed by soil and organic matter, (4) moved in solution with water, or (5) attached to soil and organic particles and moved with sediment.

What happens to a chemical after it is applied depends on the chemical's composition and environmental conditions at the application site. Some dissipate quickly, but others will remain indefinitely on the site until moved with sediment or water or consumed by plants. Chemical management should be evaluated considering the local water resource's vulnerability to chemical loads, water budget, and the following factors:

1. Nitrates. Nitrate is mobile with water. In areas with vulnerable aquifers, nitrogen should be applied in increments and quantities limited to the plant's needs. This management technique will minimize the likelihood of nitrogen movement from the root zone.

2. Phosphorus. Phosphorus adsorbs to soil and organic matter. Some soils, however, have a higher affinity for phosphorus than others. As soils become saturated with phosphorus, the excess moves with runoff. In such soils, phosphate fertilizer or animal waste need to be judiciously managed to avoid contamination of surface waters.

3. Pesticides. Pesticide movement depends on the chemical composition of the product and soil characteristics. The tendency of specific chemicals to move with water or soil, or in combination with both, has been categorized in the Pesticide Data Base (section I-5) and Soil-Pesticide Interaction Ratings (section II-1). The pesticide and soil characteristics must be assessed as part of the pesticide management practice.

4. Natural chemicals. Some chemicals, such as salts, may occur naturally in soils or rock minerals. Water management is the only means available for reducing the adverse effects from salts on surface or ground water.

As states implement water resource-related changes in FOTG's, they may consider the following training materials to help insure that field staffs understand and are able to use these concepts:

1. SCS Water Quality Training slide/tape program, module 2, "Water Quality Principles and Pollutant Delivery," and module 3, "Factors Affecting Water Quality."

2. SCS Water Quality Field Guide, SCS-TP-160 issued September,1983.

3. Principles of Ground Water for Resource Management Systems, Field Level Training Manual.

4. Local Irrigation Guide.

5. Water Quality Indicators Guide: Surface Water, July 1, 1988. Distributed and use by SCS.

Locally developed research, studies, and data may also be available to provide local information and examples of these concepts and processes.

D. Technical Information for Chemical Budgets

Soil Rating for Nitrate and Soluble Nutrients

This section provides a way to determine the degree to which water percolates below the rootzone in certain soils. Percolating water containing dissolved nitrates or other soluble nutrients could be a hazard to ground water. The method is based on a Leaching Index (LI)[1].

For areas with ground water concerns, the LI should be determined to evaluate the potential for contaminating the ground water with soluble nutrients. The LI uses annual precipitation, hydrologic soil group, and rainfall distribution data.

Leaching index

A LI map for each hydrologic soil group was developed for each state and is being provided during the Water Quality workshops. The hydrologic group describes those soils that do not have dual hydrologic ratings because of differences in drainage. Soils with hydrologic rating such as A/D should be evaluated on the basis of the current drainage status. If the soil has a high LI and is over a shallow aquifer, soluble nutrients– especially nitrates– may contaminate the water.

The LI does not account for irrigation. If irrigation is applied only to supply plant needs, there will be little additional loss below the rootzone. The additional loss would be relative to the precipitation events after the soil profile is saturated or nearly saturated due to irrigation.

In areas of marginal water quality, the amount of irrigation water applied includes a leaching fraction to insure that salts do not build up in the soil. If a leaching fraction is applied, this amount of water must be added to the LI. For example, if the leaching fraction is 1.2 and irrigation is applied to make up a 4 inch soil-water deficit, a 4.8 inch (1.2 x 4.0 in) irrigation would be applied. The LI should be increased by 0.8 inches. The same calculation must be made for each irrigation.

Procedure

Follow these steps to determine the leaching index of a certain soil:
1. Find the soil's hydrologic group.
2. Locate the iso-leaching map for that group.
3. From the map, based on the soil location, determine the LI.

Guidelines for recommendations:

A LI below 2 inches would probably not contribute to soluble nutrient leaching below the rootzone.

A LI between 2 and 10 inches may contribute to soluble nutrient leaching below the rootzone and nutrient management should be considered.

A LI larger than 10 inches will contribute to soluble nutrient leaching below the rootzone. Nutrient management practices should be intense or soluble nutrients should not be applied. Also, consider using conservation practices that minimize infiltration, such as strip cropping rather than pipe outlet terraces.

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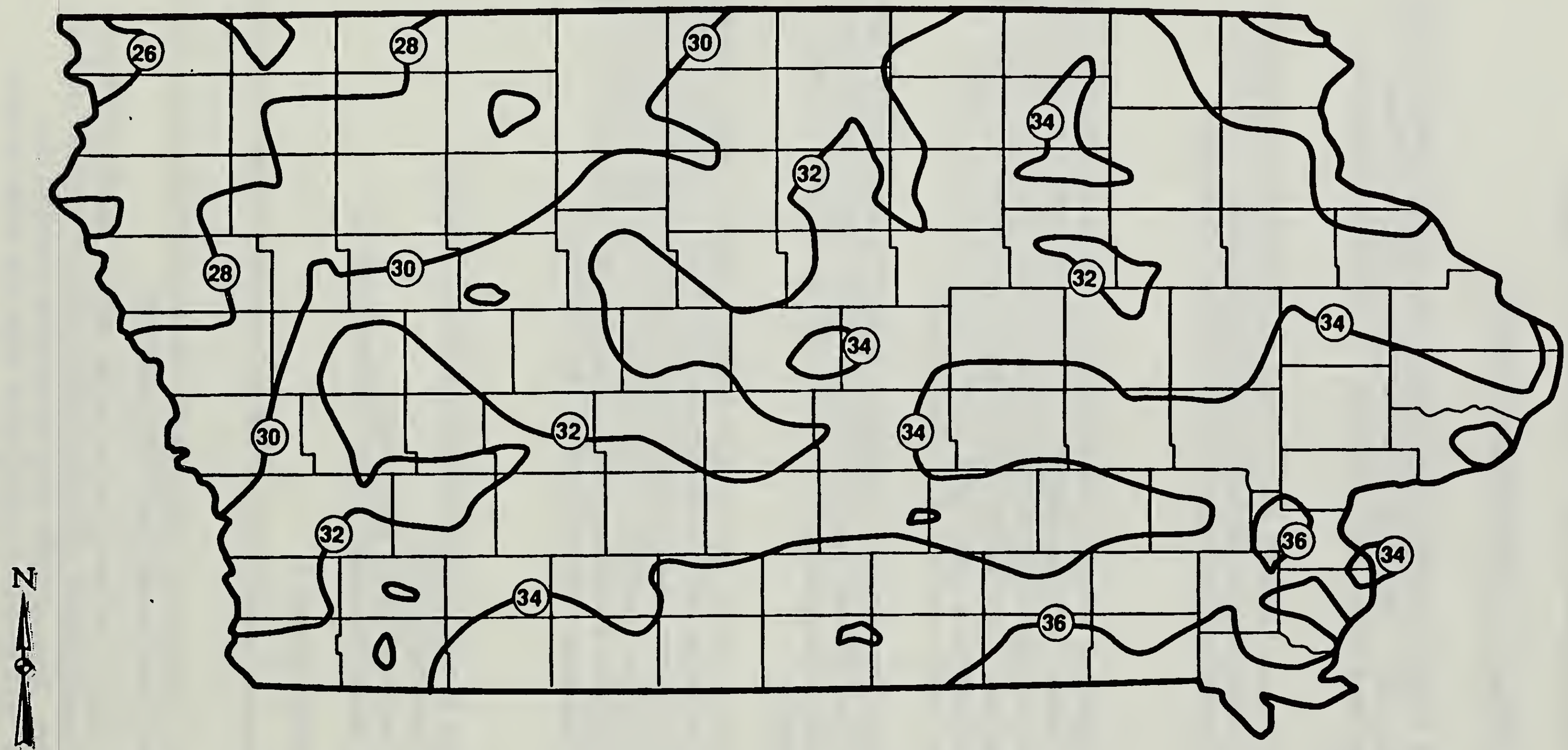
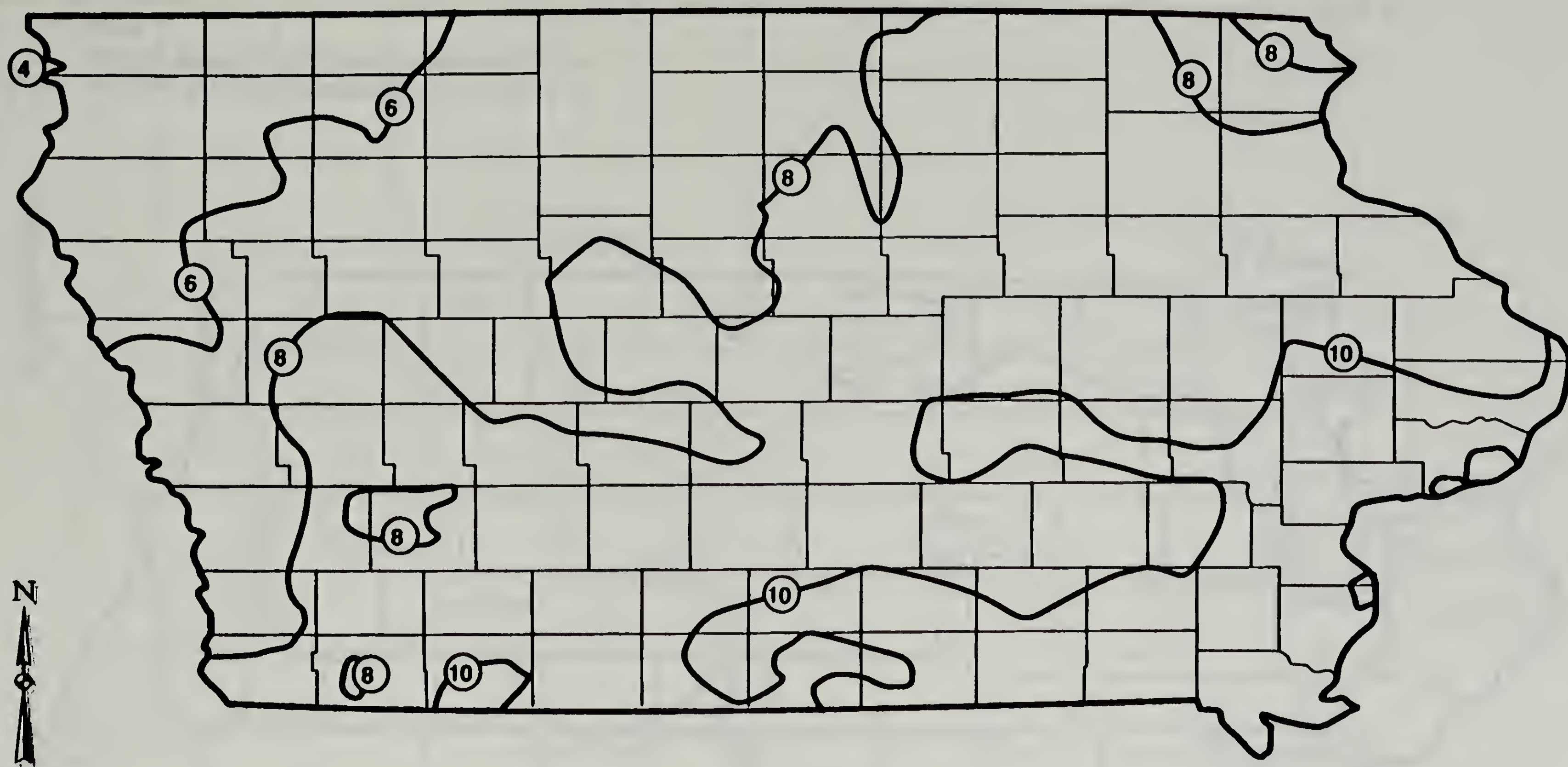
[1]The method to calculate the Leaching Index was developed by J. R. Williams and D. E. Kissel in "Water Percolation: An Indicator of N Leaching Potential", from *Managing Nitrogen For Groundwater Quality and Farm Profitability*, Edited by R. F.Follet (Unpublished).



30 Mean annual precipitation in inches

Note: Map not to scale

Map 1.
Mean Annual Precipitation
Iowa

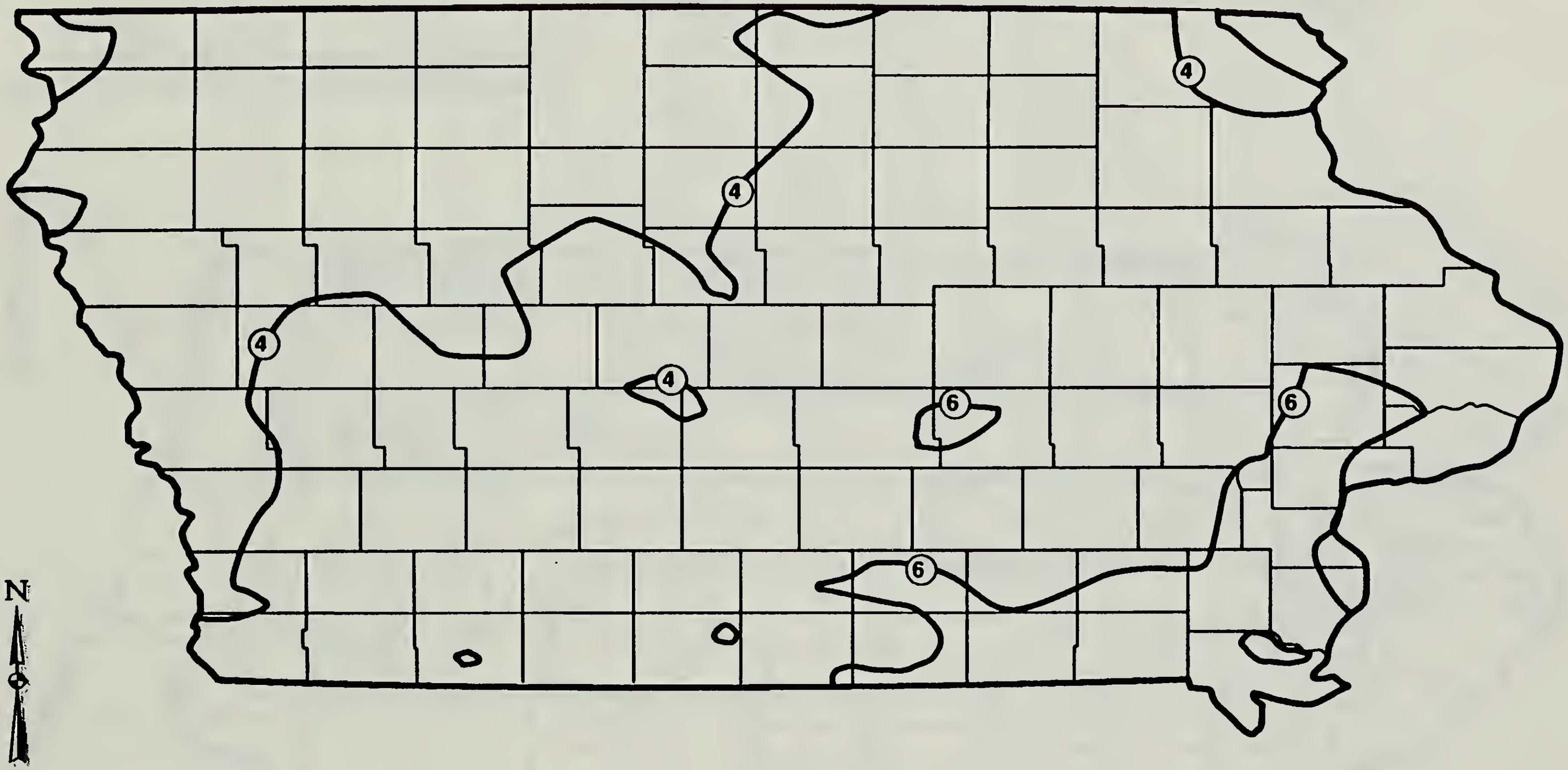


(8) Leaching (Li) index number indicating 8 inches of leaching below the root zone of this hydrologic soil group.

Note: Map not to scale

Map 2.

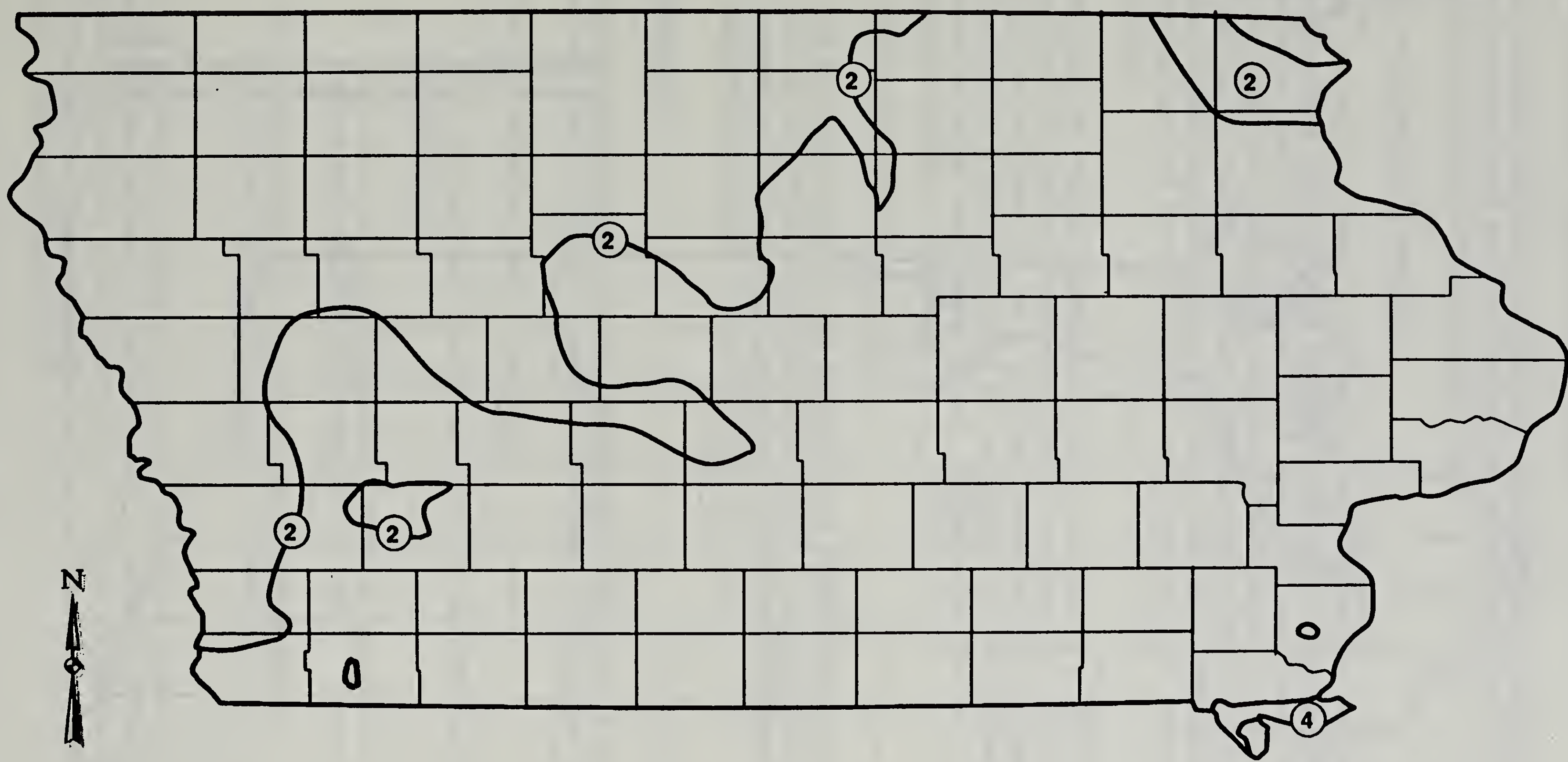
Leaching Index Map
Hydrologic Group A
Iowa



4 Leaching (Li) index number indicating 4 inches of leaching below the root zone of this hydrologic soil group.

Note: Map not to scale

Map 3.
Leaching Index Map
Hydrologic Group B
Iowa

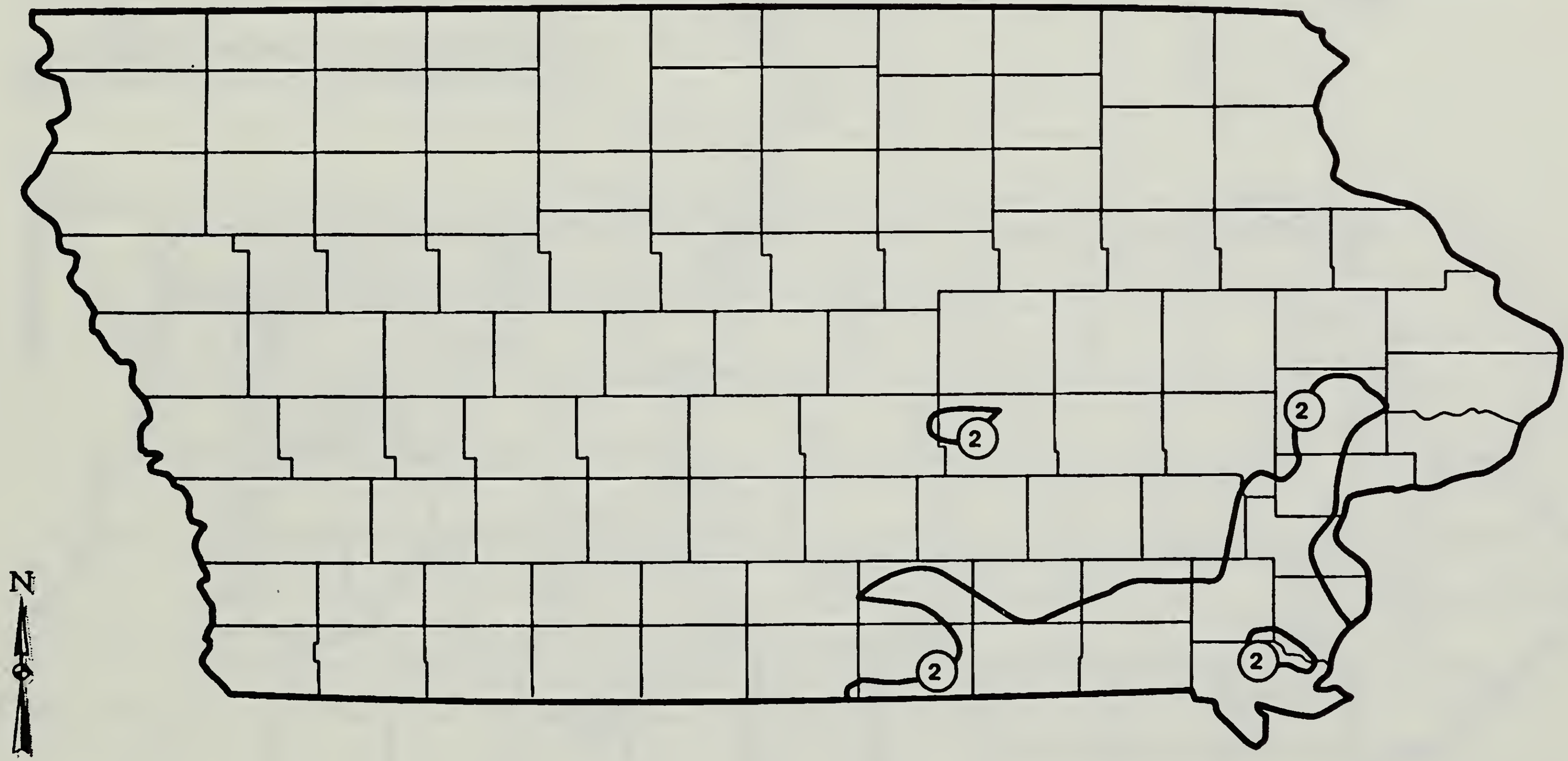


2 Leaching (Li) index number indicating 2 inches of leaching below the root zone of this hydrologic soil group.

Note: Map not to scale

Map 4.

Leaching Index Map
Hydrologic Group C
Iowa



(2) Leaching (Li) index number indicating 2 inches of leaching below the root zone of this hydrologic soil group.

Note: Map not to scale

Map 5.
Leaching Index Map
Hydrologic Group D
Iowa

Soil-Pesticide Interaction Ratings

Soil-pesticide interaction ratings help determine the potential for pesticide loss from surface runoff and from leaching or percolation below the root zone when a specific pesticide is used on a specific soil.

Soil and pesticide ranking

Soils are ranked according to potential for pesticide loss from surface runoff and from leaching. Soils ranking tables are available to the states from the same location as the SOILS-5 data at Ames, Iowa. The state staff should get these tables from Iowa and distribute to the field offices only those soils ranking tables that are pertinent to each individual field office. The tables list the soil series, surface loss potential, and leaching potential. The soil surface loss potential and soil leaching potential are ranked as **high, intermediate, or nominal.**

Pesticides are ranked according to potential for loss to surface runoff and leaching. The pesticide ranking tables are in section I-5, Pesticide Data Base. In this section there is a list of pesticide properties that include the surface loss potential and leaching potential for each pesticide. The surface loss potential is ranked as **large, medium, or small.** The leaching potential is ranked as **large, medium, small, or total use.**

Which procedure to use:

The field office staff should determine the water resource concern (e.g. ground water or surface water quality), then select the appropriate procedure. The respective procedure determines the potential loss of a pesticide when used on a particular soil.

Procedure

Both the pesticide rank and the soil rank are used to determine the potential for pesticide loss into surface runoff or to leaching. Follow these steps:

Potential Pesticides Loss to Leaching:

1. Find the leaching potential for the soil series from the soil ranking tables.

2. Determine the pesticide leaching Potential from the Pesticide Properties in Section I-5, Pesticide Data Base.

3. Use these ratings with the *Potential pesticide loss to leaching matrix* (fig. 1) to determine potential 1-3.

Using the Matrix: In figure 1 on the next page, the intersection of the soil leaching potential and the pesticide leaching potential gives the overall leaching potential— a potential 1, 2, or 3. For example, the shaded "Potential 3" area was from a soil with intermediate soil leaching potential and a pesticide with a small leaching potential.

Soil leaching potential	Pesticide leaching potential			
	Large	Medium	Small	Total use
High	Potential 1	Potential 1	Potential 2	Potential 3
Intermediate	Potential 1	Potential 2	Potential 3	Potential 3
Nominal	Potential 2	Potential 3	Potential 3	Potential 3

Figure 1. *Potential pesticide loss to leaching matrix*

Surface runoff:

1. Find the soil surface loss potential for the soil series from the soil ranking tables. If the soil mapping unit has a slope equal or less than 2%, reduce the soil surface loss potential by one unit, i.e. intermediate to nominal.

2. Determine the pesticide surface loss potential from the Pesticide Properties in Section I-5, Pesticide Data Base.

3. Use these ratings with the *Potential pesticide loss to surface runoffmatrix* (fig. 2) to determine Potential 1-3.

Soil surface loss potential	Pesticide surface loss potential		
	Large	Medium	Small
High	Potential 1	Potential 1	Potential 2
Intermediate	Potential 1	Potential 2	Potential 3
Nominal	Potential 2	Potential 3	Potential 3

Figure 2. *Potential pesticide loss to surface runoff matrix*

General Considerations: The introduction of the "Pesticide Data Base", I-5-1 to I-5-5 should be read and understood. The method of application should be considered. Keep in mind that: (1) Foliar applications can result in only a small portion of a pesticide reaching the soil surface where it can be subject to loss. (2) Pesticides applied in a band below the surface or incorporated into the soil may have a lower loss to surface runoff but a higher loss to leaching than estimated by this technique. Take this into consideration when these methods of application are used. Consult locally developed guidelines or the manufacturer.

The pesticide data base lists the solubility in water, half-life in soil, and soil sorption index. These factors were used in estimating the surface loss and leaching potential of the pesticide. Some of the factors may have an 'E' (estimated value) or 'G' (guess value). If an updated estimate of the pesticide surface loss or leaching potential is available from the manufacturer or other sources, use it.

The probability of rainfall soon after pesticide application should be considered in most climates. The loss estimates used in this procedure assume considerable precipitation immediately after application. If little or no precipitation occurs, a significant loss may not occur. Considerations in this

area depend largely on the half-life of the pesticide. After the elapse of one half-life, one-half of the original pesticide concentration has been degraded, thus one-half remains. A pesticide with a half-life of 4 days will be at 25% of original concentration in 8 days (two half-life periods). Thus, if a rainfall event is not expected for a time equal or greater to three times the half-life of the pesticide, little pesticide loss would be expected.

Potential 1: This pesticide applied on this soil has a high probability of being lost to surface runoff or leaching. Before deciding to use Potential 1 pesticides, they should be evaluated for their health hazard to humans and animals. If a pesticide is a potential danger to health, an alternative pesticide, or other pest management techniques should be selected. Carefully evaluate the factors listed in the "General Considerations" section and the additional considerations as follows:

The following guidelines are provided for use of Potentials 1, 2, and 3:

Determine the sensitivity of the surface water resource. Ask such questions as: Is the water used for drinking or recreation? Where is the field located in relation to the water resource?

If a herbicide is being used consider vegetation adjacent to the application area. Will surface loss affect the vegetation? Will aquatic vegetation be affected if a pond or lake will receive surface runoff from the area?

If ground water is a concern, questions might include: what is the health risk? What is the depth to the aquifer? Where is the nearest well withdrawal? What is the rate of water leaching from soil into the aquifer?

If the pesticide poses a potential problem to a water resource, the land user should consider such items as: (1) alternative pesticides, (2) alternative pesticide application techniques, (3) biological control such as insect attractant traps, and (4) crop management techniques such as rotations.

Potential 2: Potential 2 is a gray area. This pesticide applied on this soil has the possibility of being lost to surface runoff or leaching. However the possibility of loss is not as great as Potential 1. The effect of the pesticide on the water resource will need additional site evaluation. Refer to the guidelines for Potential 1.

Potential 2 guidelines differ from Potential 1 in: (1) the pesticide surface loss potential may be reduced one rank, i.e., large to medium, if foliar applied, incorporated, or banded under the surface, (2) the pesticide leaching potential could be reduced one rank if foliar applied, and (3) the use of this pesticide on this soil could be considered similar to potential 3 if the rainfall probability is low.

Potential 3: This pesticide applied on this soil has very low probability of being lost to surface runoff or leaching. This pesticide could be used according to label with little hazard to the respective water resource.

Pesticide Data Base

Some pesticide properties have an obvious effect on water quality while others are more subtle. The pesticide data used in this document provides estimates of pesticide properties to determine relative risk to water resources. To estimate site-specific water quality risks, the effect of pesticide properties must be considered in relation to that site's characteristics, such as kind of soil, slope, depth to ground water, potential for runoff, and expected uses of the ground and surface water.

The pesticide properties data in this document was retrieved from the "USDA-ARS Interim Pesticide Properties Database, Version 1.0" by R. D. Wauchope, August 5, 1988. As these values are updated, they will be placed into the database and submitted to the state offices.

The data base has some limitations, which include:

1. The list of U.S. Environmental Protection Agency (EPA) approved active ingredients (abbreviated "ai") changes rapidly, as does the list of approved uses for each "ai." Field office staffs should not make pesticide use recommendations based on the pesticide data base. The data base only provides data for evaluating relative risks to water resources. Specific recommendations should be based on the latest information from the Extension Service and state regulatory agencies.

2. The estimates of risk to water resources in the data base or derived from the data base should not be considered precise—there are too many variables involved. The estimates of risk should be considered a first approximation and a guide for better management.

When the predictions of risk are *extremely safe, or extremely risky*, predictions may be used with confidence. For all intermediate predictions, judgment will be needed. If risk is relatively high and lower-risk pesticide options are available, the lower-risk options should be used. If lower-risk pesticide options are not available, the user should be advised on other alternatives such as tillage for weed control or crop rotations to reduce pests.

A description of each pesticide property in the data base follows. Pesticides are listed in alphabetical order by common name.

Common name

The common names are generic names. They refer to a chemical compound without naming a specific product. There are a few pesticides which do not have a common name. These are listed by trade name.

In some cases, one common name may be used for several chemically-related compounds. "2,4-D," for example, is available in the acetic acid form, the ester form, and soluble salt form. These three forms of 2,4-D have considerably different properties, so as pesticides, they are listed separately. Still, many people refer to all forms by the common name, "2,4-D."

Table 1. *Water Polution Risk for Pesticides — Minnesota*

SIR NUMBER POTENT	SERIES NAME	SURFACE TEXTURE	HYD GRP	LAYER DEPTH	ORG MAT	K FAC	WAT TAB DEPTH	SLP UPP	SOIL LEACH POTENTIAL	SOIL SURFACE LOSS
MN0186	AASTAD NONFLOODED, PE>44	CL	B	19	4 -6	.24	3.0-6.0	6	NOMINAL •	INTERMEDIATE
MN0186	AASTAD NONFLOODED, PE>44	L	B	19	4 -6	.24	3.0-6.0	6	NOMINAL •	INTERMEDIATE
ND0119	BARNES	L, SIL	B	7	3 -7	.28	>6.0	25	INTERMEDIATE*	INTERMEDIATE*
ND0119	BARNES	CL	B	7	3 -7	.28	>6.0	25	INTERMEDIATE*	INTERMEDIATE*
ND0119	BARNES	SL	B	7	2 -7	.20	>6.0	25	INTERMEDIATE*	INTERMEDIATE*
ND0219	BARNES MODERATE PERMEABILITY	L, SIL	B	7	2 -5	.28	>6.0	25	INTERMEDIATE*	INTERMEDIATE*
ND0219	BARNES MODERATE PERMEABILITY	FSL	B	7	2 -5	.20	>6.0	25	INTERMEDIATE*	INTERMEDIATE*
ND0219	BARNES MODERATE PERMEABILITY	SCL	B	7	2 -5	.28	>6.0	25	INTERMEDIATE*	INTERMEDIATE*
SD0206	ESTELLINE	SIL	B	6	4 -8	.32	>6.0	9	INTERMEDIATE	INTERMEDIATE
SD0206	ESTELLINE	SICL	B	6	4 -8	.32	>6.0	9	INTERMEDIATE	INTERMEDIATE
MN0025	ESTHERVILLE	SL, COSL	B	13	2 -4	.20	>6.0	25	INTERMEDIATE*	INTERMEDIATE*
MN0025	ESTHERVILLE	L	B	13	2 -4	.20	>6.0	25	INTERMEDIATE*	INTERMEDIATE*
MN0102	FOSSUM	SL, FSL	A	13	3 -6	.20	1.0-2.5	2	INTERMEDIATE •	NOMINAL
MN0102	FOSSUM	LS, LFS	A	13	2 -5	.17	1.0-2.5	2	INTERMEDIATE •	NOMINAL
MN0102	FOSSUM	L	A	13	3 -6	.24	1.0-2.5	2	INTERMEDIATE •	NOMINAL
MN0102	FOSSUM	SL, FSL	D	13	3 -6	.20	1.0-2.5	2	NOMINAL•	NOMINAL
MN0102	FOSSUM	LS, LFS	D	13	2 -5	.17	1.0-2.5	2	NOMINAL•	NOMINAL
MN0102	FOSSUM	L	D	13	3 -6	.24	1.0-2.5	2	NOMINAL •	INTERMEDIATE
MN0424	FOSSUM PONDED	SL, FSL	A	13	3 -6	.20	+1 -1.0	2	INTERMEDIATE •	NOMINAL
MN0424	FOSSUM PONDED	LS, LFS	A	13	2 -5	.17	+1 -1.0	2	INTERMEDIATE •	NOMINAL
MN0424	FOSSUM PONDED	L	A	13	3 -6	.24	+1 -1.0	2	INTERMEDIATE •	NOMINAL

* SLOPES GREATER THAN 15 PERCENT REQUIRE LOCAL EVALUATION
\# ORGANIC SOILS AND SOILS WITH ORGANIC SURFACE LAYERS REQUIRE LOCAL EVALUATIONS
• WATER TABLE ABOVE 6 FEET MAY REQUIRE CONSIDERATION OF WATER RESOURCE USE

Table 2. *Pesticide Worksheet*

(Surface) (Subsurface)

SOIL	CROP	MANAGEMENT	TARGET PEST	RECOMMENDED PESTICIDE	LOSS POTENTIAL: PESTICIDE SUR	PESTICIDE LEA	SOIL SUR	SOIL LEA	OVER ALL SUR	OVER ALL LEA
Barnes	Corn	Sprinkler Irrigation,	Green and	atrazine	M	L	I	I	2	1
	4%	Continuous corn,	yellow and	cyanazine	M	M	I	I	2	2
		Clean cultivation,	foxtail,	EPTC	M	M	I	I	2	2
		Herbicide preplant	Lambsquarters	EPTC	M	M	I	I	2	2
		incorporated	Pigweed	metolachlor	M	M	I	I	2	2
Salida	Alfalfa	Second year stand,	Foxtail	pronamide	L	S	N	H	2	2
5%		Sprinklerirrigation,		sethoxydim	S	S	N	H	3	2
Barnes	Corn	Continuous corn,	Corn	Tebufos	M	S	I	I	2	3
4%		Sprinkler irrigation,	rootwrom	Fonofos	L	M	I	I	1	2
		Clean cultivation		Chlorpyrifos	L	S	I	I	1	3
				Carbofuran	S	L	I	I	3	1
				Phorate	L	M	I	I	1	2

SUR=SURFACE
LEA=LEACHING

PESTICIDE:
L= LARGE
M = MEDIUM
S= SMALL
T = TOTAL USE

SOIL: OVERALL:
H = HIGH
I = INTERMEDIATE
N = NOMINAL

1 = HIGH
2 = GRAY
3 = LOW

Table 3. *Leaching Index Worksheet*

SOIL	HYDR-LOGIC GROUP	COUNTY	LI FROM MAP	ADDITIONAL LEACHING FROM IRRIGATION *Inches*	SUM LEACH-ING *Inches*	OTHER CONSIDERATIONS
Zimmerman LFS	A	Anoka	4-8 (6)	2	8	Nutrients usually applied in spring
Estherville SL	B	Pope	<2	3	5	Shallow water table usually < 15 feet
Frankville SIL	B	Olmstead	2-4 (4)	0	4	Fractured bedrock near surface, potable water source at 60 feet.

Additional leaching from irrigation is that amount used as a leaching fraction when saline water is applied. Also, add any amount of irrigation added that is greater than that required to fill the rootzone to field capacity

Other considerations. Any factors that may increase or decrease the expected infiltration of precipitation; i.e. tillage, residue management, contouring. Factors that may decrease the loss of soluble nutrients; i.e. solubility, time of application along with time of maximum leaching. The LI is the average leaching for the year. If large amounts of precipitation fall in the winter, the majority of the leaching could be expected in winter months. Geologic and water table considerations; i.e. depth to potable water source, fractured bed rock, distance to nearest well.

Consider any factors affecting nutrient/water balance.

U.S. trade name and manufacturers

Some pesticide compounds are formulated as trade name products for sale by only one manufacturer. Compounds that have outlived patent protection, however, may have several trade names. The limited list of trade names in the data base is from the Crop Protection Chemicals Reference and the BASF Company literature.

Other trade name products not in the data base will usually have the common name of the active ingredient on the label.

A specific EPA-registered product must have a defined "ai" at a defined concentration. Some companies, however, confuse things by using nearly the same trade name for two or more products containing entirely different active ingredients.

To further complicate the issue, state recommendations often avoid mentioning trade names.

So if a trade name is given by a user, more than one active ingredient may be involved. If a common name is given, many trade names, several different formulations, and possibly chemical derivatives may be involved. Whether a trade name or common name is used, planners must know what the active ingredients are, and at what concentration.

Use

The use listing is included for general information. It is not complete because of frequent changes in the registered uses and should not be followed as a recommendation. Most of this information was taken from labels.

Formulation type

Formulation is the physical form in which a product is packaged and is specific for a given product. For example, "D.Z.N. Diazinon 4E" is a product of Ciba-Geigy which contains four pounds of diazinon per gallon and is a 47.5% diazinon solution. The diazinon is dissolved in a hydrocarbon solvent with surfactants, which allow the solution to be easily mixed with water to form an emulsion suitable for spraying.

Formulation type is important in predicting pesticide behavior. The long-term (weeks to months) life of a pesticide will be a function of its physical properties and persistence, but its initial life (hours to days) will be a function of its formulation. For example, about 30 times more wettable powders than emulsified concentrates will be lost if both are applied to soil surfaces and immediately subjected to rain.

Most formulation types are designed to be mixed with water and sprayed through nozzles. These formulations can be described as:

1. Wettable powders which are added to spray water and kept in suspension by agitation.

2. Aqueous concentrates which are water-based mixtures diluted with spray water.

3. Emulsifiable concentrates which form emulsions in the spray tank and are kept mixed by agitation.

4. Dispersible liquids which are suspensions of very fine pesticide particles in a thick liquid and thinned with spray water.

5. Dispersible granules which are powders formed into granules and break down on contact with water and form a suspension similar to wettable powders.

6. Soluble solutions are solutions of the "ai" in a solvent that is mixable with water.

7. Microcapsules which are tiny polymer spheres containing the "ai" and suspended in water.

8. Soluble powders which dissolve in water.

Formulations which are not designed to be mixed in water include granules and pellets which are applied by spreaders, and oil-based materials designed to be sprayed in various oils.

Application mode

The application mode is important in determining the primary location of the pesticide in the target area. The pesticide location determines the initial behavior. The importance of location is illustrated by comparing Trifuralin, a herbicide, and Carbaryl, an insecticide.

Trifuralin is typically applied as a spray to a bare soil surface and mixed in. It is volatile and will evaporate if left on the surface. Weeds are killed as they sprout in the soil.

Carbaryl, a wettable powder, is applied to vegetation such as apple trees for insect control and is easily washed off leaves by water.

Trifuralin is fairly persistent but is a low runoff risk because it is incorporated in soil. Carbaryl has a high runoff potential because it is a wettable powder applied to leaves. Carbaryl persistence, however, is short, as the active ingredients dissipate rapidly when exposed to sun and wind.

The application mode depends on the spray target, such as weed or crop plants, and whether it is applied to the soil surface or incorporated in the soil. Both runoff and persistence will be strongly affected by where the active ingredient ends its flight from nozzle. In many cases, the final location of the pesticide will be divided between soil, foliage, and air. Only the major deposition location is listed in the data base.

Solubility in water

The solubility of the pesticides in water at room temperature is given in ppm (mg/l). This is the solubility of the pure ai, not the formulated product. Solubility is a fundamental physical property of a chemical and will strongly effect the ease of washoff and leaching through soil. In general, pesticides with solubilities of 1 ppm or less will tend to stay at the soil surface and be washed off the field in the sediment phase of runoff. Thus practices designed to reduce erosion will also stop pesticide runoff. An "E" code means the solubility value given is an estimate and may be in error by up to a factor of three. A "G" code means literally that a guess estimate of the solubility has been made and the error may be one or two orders of magnitude.

Half-life in soil

Half-life, given in days, is the time required for pesticides in soils to be degraded so that their concentration decreases by one-half. Pesticide degradation can be fairly accurately described by assuming that each successive elapsed half-life will decrease the pesticide concentration by half, so, for example, a period of two half-lives will reduce a soil concentration to one-fourth of the initial amount. "Persistence times" often reported in the literature are the times required for a pesticide to degrade to the point that it is no longer active. We have arbitrarily assumed this equal to four half-lives when a persistence time was the only data available.

Half-lives vary by a factor of three or more depending on soil moisture, temperature, oxygen status, soil microbial population and other factors. The numbers given should only be used as relative indicators of persistence. "E" codes mean the value is estimated and is probably in error by a factor of two or more. "G" codes mean the estimate could be off by a factor of three or more.
These half-lives are for pesticides in the interior of the soil and generally refer to chemical or microbiological degradation. Pesticides deposited on the soil surface or deposited on leaf or crop litter surfaces, and remaining there because of an absence of rain, are also subject to evaporation and sunlight and generally show half-lives of only a few days or less.

Soil sorption index

The index for soil sorption is measured by the Koc value. The Koc measures the tendency of the pesticide to be strongly attached, by chemical or physical bonds, to soil particle surfaces. The higher Koc values (1000)have a stronger attachment to soil and a lesser tendency for the pesticide to move except with sediment movement. Conversely, the lower Koc values will tend to move with water and have a potential for deep percolation below the root zone or being carried in runoff water. The "E" code means a probable error of 3x - 5x and a "G" code means a probable error of 10x - 100x.

C. A. reference

The C.A. Reference is a number assigned by the Chemical Abstract Service of the American Chemical Society (ACS) to a specific chemical compound. When a new chemical is developed, it is described in an abstract and registered with the ACS. The society assigns a number to the compound to be used as a reference by the chemical profession.

Runoff potential

The runoff potential indicates the tendency of the pesticide to move with sediment in runoff. A large rating means the pesticide has a high tendency to move with sediment while a small rating means the pesticide has a low potential to move with sediment. The pesticide runoff potential rating should be used in conjunction with the Soil Pesticide Interaction Ratings, section II-1, to evaluate pesticide movement.

Leaching potential

The leaching potential indicates the tendency of a pesticide to move in solution with water and leach below the root zone into deep percolation. The ratings of large, medium, small, and total use describes the potential for leaching. A rating of large means the chemical has a high potential for leaching. The total use rating means the pesticide should not leach with the percolating water. The pesticide leaching potential should be used in conjunction with the Soil Pesticide Interaction Ratings in section II-1 to evaluate pesticide movement.

2,4-D ACID

Trade name(s): Dacamine (mixture with 2,4-D amine salt)
Manufacturer(s): Fermenta
Use: herbicide: lawns, orchards, grains, rice, corn, sorghum
Formulation type(s): aqueous solution
Application mode(s): target weed foliar spray
Solubility in water (mg/l): 890
Half life in soil(days): 10
Soil sorption index ('Koc'): 20
C.A. Reference: 94-75-7
Surface loss potential: SMALL
Leaching potential: MEDIUM

2,4-D ESTER OR OIL-SOLUBLE AMINE

Trade name(s): Aqua Kleen, Weedone, Emulsamine
Manufacturer(s): Fermenta, Rhone-Poulenc
Use: herbicide: aquatic weeds, grains, corn, sorghum, sugarcane, noncropland
Formulation type(s): granules, emulsifiable concentrate
Application mode(s): granules applied to water surface; weed foliar spray
Solubility in water (mg/l): 50 E
Half life in soil(days): 10
Soil sorption index ('Koc'): 1000 E
C.A. Reference: 1928-38-7
Surface loss potential: MEDIUM
Leaching potential: SMALL

2,4-D SOLUBLE AMINE SALT

Trade name(s): Weedar
Manufacturer(s): Rhone-Poulenc
Use: herbicide: lawns, noncroplands, grains, corn, rice, sugarcane, pasture, orchards, vegetables, sorghum
Formulation type(s): aqueous solution
Application mode(s): target weed foliar spray
Solubility in water (mg/l): 300000
Half life in soil (days): 10
Soil sorption index ('Koc'): 109
C.A. Reference: 94-82-6
Surface loss potential: MEDIUM
Leaching potential: MEDIUM

2,4-DB ESTER

Trade name(s): Butyrac Ester
Manufacturer(s): Rhone-Poulenc
Use: herbicide: alfalfa, birdsfoot trefoil
Formulation type(s): emulsifiable concentrate
Application mode(s): target weed foliar spray
Solubility in water (mg/l): 50 E
Half life in soil(days): 10 E
Soil sorption index ('Koc'): 1000 E
C.A. Reference: 94-82-6
Surface loss potential: MEDIUM
Leaching potential: SMALL

2,4-DB SOLUBLE SODIUM OR AMINE SALT

Trade name(s): Butyrac, Rescue (mixture with naptalam soluble salt)
Manufacturer(s): Rhone-Poulenc, Union Carbide
Use: herbicide: peanuts, soybeans, alfalfa, clover, forage legumes
Formulation type(s): concentrated aqueous solutions
Application mode(s): seedling weed foliar spray
Solubility in water (mg/l): 200000
Half life in soil(days): 10 E
Soil sorption index ('Koc'): 20 E
C.A. Reference: 94-82-6
Surface loss potential: SMALL
Leaching potential: MEDIUM

3-CPA SOLUBLE SODIUM SALT

Trade name(s): Fruitone CPA
Manufacturer(s): Rhone-Poulenc
Use: growth regulator: pineapple
Formulation type(s): aqueous solution
Application mode(s): crop plant spray
Solubility in water (mg/l): 200000
Half life in soil(days): 10 E
Soil sorption index ('Koc'): 20 E
C.A. Reference:
Surface loss potential: SMALL
Leaching potential: MEDIUM

A selection of fields and records from the USDA-ARS, *Interim Pesticide Properties Data Base,* Version 1.0, by R.D. Wauchope. Surface loss and Leaching potentials by Soil Conservation Service.
E=Estimate value; probable error is 2X to 3X for Half life, and 3X to 5X for Solubility and 'Koc'
G= Guess value; probable error is 5X for Half life, and 1 to 2 orders of magnitude for Solubilities and 'Koc'

ACEPHATE

Trade name(s): Orthene
Manufacturer(s): Chevron
Use: insecticide: cotton, soybeans, vegetables, forests, tobacco, ornamentals, insect control in buildings, pasture, rangeland
Formulation type(s): water soluble powder; dust
Application mode(s): crop foliar spray, spot spray
Solubility in water (mg/l): 650000
Half life in soil(days): 3
Soil sorption index ('Koc'): 100
C.A. Reference: 30560-19-1
Surface loss potential: SMALL
Leaching potential: SMALL

ACIFLUORFEN SOLUBLE SODIUM SALT

Trade name(s): Tackle, Blazer
Manufacturer(s): Rhone-Poulenc, BASF
Use: herbicide: soybeans, peanuts, other legumes, rice
Formulation type(s): concentrated aqueous solution
Application mode(s): soil spray, target plant foliar spray
Solubility in water (mg/l): 900000
Half life in soil(days): 30
Soil sorption index ('Koc'): 139
C.A. Reference: 62476-59-9
Surface loss potential: MEDIUM
Leaching potential: MEDIUM

ALACHLOR

Trade name(s): Lasso
Manufacturer(s): Monsanto
Use: herbicide: corn, soybeans, dry beans, potatoes, cotton, peanuts, sugarcane, sunflowers, tobacco, ornamentals, turf
Formulation type(s): EC; dispersible granules; microencapsulated
Application mode(s): soil spray, soil granular application, soil incorporated
Solubility in water (mg/l): 242
Half life in soil(days): 14
Soil sorption index ('Koc'): 190
C.A. Reference: 15972-60-8
Surface loss potential: MEDIUM
Leaching potential: MEDIUM

ALDICARB

Trade name(s): Temik
Manufacturer(s): Rhone-Poulenc
Use: systemic insecticide, nematicide: citrus, cotton, beets, potatoes, peanuts, pecans, sorghum, soybeans, sugarcane
Formulation type(s): Granules
Application mode(s): granular application to soil, often with incorporation
Solubility in water (mg/l): 6000
Half life in soil(days): 30
Soil sorption index ('Koc'): 30
C.A. Reference: 116-06-3
Surface loss potential: SMALL
Leaching potential: LARGE

AMETRYN

Trade name(s): Evik
Manufacturer(s): Ciba-Geigy
Use: herbicide: sugarcane, corn, noncrop; dessicant: potatoes
Formulation type(s): wettable powder
Application mode(s): soil surface spray, sometimes incorporated
Solubility in water (mg/l): 185
Half life in soil(days): 30
Soil sorption index ('Koc'): 388
C.A. Reference: 834-12-8
Surface loss potential: MEDIUM
Leaching potential: MEDIUM

AMIDOCHLOR

Trade name(s): Limit
Manufacturer(s): Monsanto
Use: plant growth regulator: turf
Formulation type(s): dispersible liquid
Application mode(s): applied to turf foliage
Solubility in water (mg/l): 10 G
Half life in soil(days): 20 G
Soil sorption index ('Koc'): 1000 G
C.A. Reference:
Surface loss potential: MEDIUM
Leaching potential: SMALL

A selection of fields and records from the USDA-ARS, *Interim Pesticide Properties Data Base*, Version 1.0, by R.D. Wauchope. Surface loss and Leaching potentials by Soil Conservation Service.
E=Estimate value; probable error is 2X to 3X for Half life, and 3X to 5X for Solubility and 'Koc'
G= Guess value; probable error is 5X for Half life, and 1 to 2 orders of magnitude for Solubilities and 'Koc'

AMITRAZ

Trade name(s): Mitac
Manufacturer(s): Nor-Am
Use: insecticide-acaricide; fruit, citrus, cotton, other crops; livestock dip
Formulation type(s): emulsifiable concentrate, wettable powder
Application mode(s): crop foliar spray
Solubility in water (mg/l): 1
Half life in soil(days): 20 G
Soil sorption index ('Koc'): 1000 E
C.A. Reference: 33089-61-1
Surface loss potential: MEDIUM
Leaching potential: SMALL

AMITROLE

Trade name(s): Amitrol T, Amizol
Manufacturer(s): Rhone-Poulenc
Use: herbicide: noncropland
Formulation type(s): aqueous solution
Application mode(s): target weed foliar spray
Solubility in water (mg/l): 280000
Half life in soil(days): 14
Soil sorption index ('Koc'): 200
C.A. Reference: 61-82-5
Surface loss potential: MEDIUM
Leaching potential: MEDIUM

ANCYMIDOL

Trade name(s): A-Rest
Manufacturer(s): Elanco
Use: growth regulator: container ornamentals
Formulation type(s): dilute aqueous solution
Application mode(s): crop foliage or soil surface spray
Solubility in water (mg/l): 650
Half life in soil(days): 20 G
Soil sorption index ('Koc'): 120
C.A. Reference: 12771-68-5
Surface loss potential: MEDIUM
Leaching potential: MEDIUM

ANILAZINE

Trade name(s): Dyrene
Manufacturer(s): Mobay
Use: fungicide: cereals, turf, vegetables
Formulation type(s): WP
Application mode(s): crop foliar spray
Solubility in water (mg/l): 10 G
Half life in soil(days): 1
Soil sorption index ('Koc'): 3000
C.A. Reference: 101-05-3
Surface loss potential: SMALL
Leaching potential: SMALL

ARSENIC ACID

Trade name(s): Desiccant L-10
Manufacturer(s): Pennwalt
Use: defoliant: cotton
Formulation type(s): aqueous solution concentrate
Application mode(s): applied to crop foliage
Solubility in water (mg/l): 1000000 E
Half life in soil(days): 100
Soil sorption index ('Koc'): 10000 E
C.A. Reference:
Surface loss potential: LARGE
Leaching potential: SMALL

ASSERT (TRADE NAME)

Trade name(s): Assert
Manufacturer(s): American Cyanamid
Use: herbicide: wheat, barley, sunflowers
Formulation type(s): water-soluble liquid concentrate
Application mode(s):
Solubility in water (mg/l): 875
Half life in soil(days): 35
Soil sorption index ('Koc'): 35
C.A. Reference:
Surface loss potential: MEDIUM
Leaching potential: LARGE

A selection of fields and records from the USDA-ARS, *Interim Pesticide Properties Data Base*, Version 1.0, by R.D. Wauchope. Surface loss and Leaching potentials by Soil Conservation Service.
E=Estimate value; probable error is 2X to 3X for Half life, and 3X to 5X for Solubility and 'Koc'
G= Guess value; probable error is 5X for Half life, and 1 to 2 orders of magnitude for Solubilities and 'Koc'

ASULAM SOLUBLE SODIUM SALT

Trade name(s): Asulox
Manufacturer(s): Rhone-Poulenc
Use: herbicide: sugarcane, turf, ornamentals, forest, noncropland
Formulation type(s): concentrated aqueous solution
Application mode(s): applied to weed foliage
Solubility in water (mg/l): 600000
Half life in soil(days): 7
Soil sorption index ('Koc'): 40
C.A. Reference: 2302-17-2
Surface loss potential: SMALL
Leaching potential: MEDIUM

ATRAZINE

Trade name(s): AAtrex, Atratol, Atrazine,
Manufacturer(s): Ciba-Geigy, DuPont
Use: herbicide: corn, sorghum, noncropland, rangeland, sugarcane, turf
Formulation type(s): wettable powder, dispersible liquid, granules
Application mode(s): soil spray, target plant foliar spray
Solubility in water (mg/l): 33
Half life in soil(days): 60
Soil sorption index ('Koc'): 160
C.A. Reference: 1912-24-9
Surface loss potential: MEDIUM
Leaching potential: LARGE

AZINPHOS-METHYL

Trade name(s): Guthion
Manufacturer(s): Mobay, Bayer AG
Use: insecticide: soybeans, grains, pasture, cotton, fruits, vegetables, ornamentals, forest
Formulation type(s): emulsifiable concentrate, wettable powder
Application mode(s): crop foliar spray
Solubility in water (mg/l): 29
Half life in soil(days): 40
Soil sorption index ('Koc'): 1000
C.A. Reference: 86-50-0
Surface loss potential: LARGE
Leaching potential: SMALL

BENEFIN

Trade name(s): Balan, Balfin
Manufacturer(s): Elanco
Use: herbicide: turf, peanuts, tobacco, lettuce, legumes
Formulation type(s): emulsifiable concentrate, granular, dispersible granule
Application mode(s): soil incorporated; granules in turf
Solubility in water (mg/l): 0.1
Half life in soil(days): 30
Soil sorption index ('Koc'): 11000
C.A. Reference: 1861-40-1
Surface loss potential: LARGE
Leaching potential: SMALL USE

BENOMYL

Trade name(s): Benlate, Tersan
Manufacturer(s): DuPont
Use: systemic fungicide: fruits, nuts, vegetables, field crops, turf, ornamentals
Formulation type(s): wettable powder, oil-dispersible, dispersible granules
Application mode(s): crop foliar spray
Solubility in water (mg/l): 2
Half life in soil(days): 100
Soil sorption index ('Koc'): 2100
C.A. Reference: 17804-35-2
Surface loss potential: LARGE
Leaching potential: SMALL

BENSULIDE

Trade name(s): Prefar
Manufacturer(s): ICI Americas
Use: herbicide: vegetables, lawns, cotton
Formulation type(s): emulsifiable concentrate
Application mode(s): soil spray, watered-in or soil incorporated
Solubility in water (mg/l): 25
Half life in soil(days): 60
Soil sorption index ('Koc'): 10000
C.A. Reference: 741-58-2
Surface loss potential: LARGE
Leaching potential: SMALL

A selection of fields and records from the USDA-ARS, *Interim Pesticide Properties Data Base,* Version 1.0, by R.D. Wauchope. Surface loss and Leaching potentials by Soil Conservation Service.
E=Estimate value; probable error is 2X to 3X for Half life, and 3X to 5X for Solubility and 'Koc'
G= Guess value; probable error is 5X for Half life, and 1 to 2 orders of magnitude for Solubilities and 'Koc'

Section II – Water Resource Information and Evaluation

A. Water Quality Criteria, Standards and Use Classification

Two documents containing information about the subject of water quality regulations are included in this section. The Mississippi document presents criteria; the Nebraska document presents standards and use classifications. These documents establish allowable concentrations of water quality constituents for health and environment protection. They also set use classification requirements for surface and ground water on a statewide basis.

State of Mississippi

Water Quality Criteria for Intrastate, Interstate and Coastal Waters

Adopted July 17, 1985

Mississippi Department of Natural Resources
Bureau of Pollution Control
P.O. Box 10385
Jackson, Mississippi 39209

Water Quality Criteria for Intrastate, Interstate and Coastal Waters

Section I. General Conditions

1. The policy inherent in the standard shall be to protect water quality existing at the time these water quality standards were adopted and to upgrade or enhance water quality within the state of Mississippi. Waters whose existing quality is better than the established standards will be maintained at high quality unless the Commission finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the State's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In no event, however, may degradation of water quality interfere with or become injurious to existing instream water uses. Further, in no case will water quality be degraded below (or above) the base levels set forth in these standards for the protection of the beneficial uses described herein. In addition the State will assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable best management practices for nonpoint source control. Where the Commission determines that high quality waters constitute an outstanding National resource, such as waters of National and State parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

2. The limiting values of water quality herein described shall be measured by the Commission in waters under consideration as determined by good sanitary engineering practice and after consultation with affected parties. Samples shall be taken from points so distributed over the area and depth of the waters being studied as to permit a realistic appraisal of such actual or potential damage to water use or aquatic life as may exist. Samples shall be analyzed in accordance with the latest edition of "Standard Methods for the Examination of Water and Wastewater" or other methods acceptable to the Commission.

3. Certain waters of the State may not fall within desired or prescribed limitations as outlined. In such instances the Commission may authorize exceptions to these limits, under the following conditions:

  a. The existing designated use is not attainable because of natural background conditions; or

  b. The existing designated use is not attainable because of irretrievable man-induced conditions; or

  c. The application of effluent limitations for existing sources more stringent than those required pursuant to Section 301(b) (2) (A) and (B) of the Federal Water Pollution Control Act Amendments of 1972, in order to attain the existing designated use, would result in substantial and widespread adverse economic and social impact.

In no case shall it be permissible to deposit of introduce materials into waters of the State which will cause impairment of the reasonable or legitimate use of said waters.

4. In view of the fact that industry is continuing to produce new materials whose characteristics and effects are unknown at this time, such materials shall be evaluated on their merits as information becomes available to the Commission. Sources of information shall include, but not be limited to, the latest editions of Quality Criteria for Water, prepared by the Environmental Protection Agency pursuant to Section 304(a) of the Federal Water Pollution Control Act Amendments of 1972. The use of such information should be limited to that part applicable to the indigenous aquatic community found in the State of Mississippi.

5. All criteria contained herein shall apply to all stages of streamflow greater than or equal to the 7-day, 10-year minimum flow in unregulated, natural streams, and the legally guaranteed minimum flow in regulated streams. This requirement shall not be interpreted to permit any unusual waste discharges during periods of lower flow.

6. In open ocean waters there shall be no oxygen demanding substances added which will depress the dissolved oxygen content below 5.0 mg/l.

7. The Mississippi River is classified for Fish and Wildlife use, but with the following additions to the criteria stated herein:

Mineral constituents. Not to exceed the following concentrations at any time:

From Mississippi-Tennessee border to Vicksburg

Chlorides	60 mg/l
Sulfates	150 mg/l
T.D.S.	425 mg/l

From Vicksburg south to the Mississippi-Louisiana border

Chlorides	75 mg/l
Sulfates	120 mg/l
T.D.S.	400 mg/l

8. It is recognized that limited areas of mixing are sometimes unavoidable; however, mixing zones shall not be used as a substitute for waste treatment. Mixing zones constitute an area whereby physical mixing of a wastewater effluent with a receiving water body occurs. Application of mixing zones shall be made on a case-by-case basis and shall only occur in cases involving large surface water bodies in which a long distance or large area is required for the wastewater to completely mix with the receiving water body.

The location of a mixing zone shall not significantly alter the designated uses of the receiving water outside its established boundary. Adequate zones of passage for the migration and free movement of fish and other aquatic biota shall be maintained. No conditions shall be allowed to exist within the mixing zone that would result in an endangerment to public health, nuisances, or fish mortality.

Section II. Minimum Conditions Applicable to All Waters

1. **Waters shall be free from substances** attributable to municipal, industrial, agricultural or other discharges that will settle **to form putrescent or otherwise objectionable sludge deposits.**

2. **Waters shall be free from floating debris, oil, scum, and other floating materials** attributable to municipal, industrial, agricultural or other discharges in amounts sufficient to be unsightly or deleterious.

3. **Waters shall be free from materials attributable to municipal, industrial, agricultural or other discharges producing color, odor, or other conditions in such degree as to create a nuisance**. Specifically, the turbidity outside the limits of a 750-foot mixing zone shall not exceed the background turbidity at the time of discharge by more than 50 Nephelometric Turbidity Units (NTU). An exemption may be granted in cases of emergency to protect the public health and welfare.

4. **Waters shall be free from substances** attributable to municipal, industrial, agricultural or other discharges in concentrations or combinations **which are toxic or harmful to humans, animals or aquatic life.**

5. **Municipal wastes, industrial wastes, or other wastes** shall receive effective treatment or control in accordance with Section 301, 306 and 307 of the Federal Water Pollution Control Act Amendments of 1972. A degree of treatment greater than defined in these sections may be required when necessary to protect legitimate water uses.

6. **Dissolved oxygen** concentrations shall be maintained at a daily average of not less than 5.0 mg/l with an instantaneous minimum of not less than 4.0 mg/l in streams; shall be maintained at a daily average of not less than 5.0 mg/l with an instantaneous minimum of not less than 4.0 mg/l in estuaries and in the tidally affected portions of streams; and shall be maintained at a daily average of not less than 5.0 mg/l with an instantaneous minimum of not less than 4.0 mg/l in the epilimnion (i.e., the surface layer of lakes and impoundments that are thermally stratified, or 5 feet from the water's surface (mid-depth if the lake or impoundment is less than 10 feet deep at the point of sampling) for lakes and impoundments that are not stratified.

Epilimnion samples may be collected at the approximate mid-point of that zone (i.e., the mid-point of the distance or if the epilimnion is more than 5 feet in depth, then at 5 feet from the water's surface).

7. **Toxic substances, color, taste and odor producing substances**. There shall be no substances added, whether alone or in combination with other substances, that will impair the use of waters from that which it is classified. The concentration of toxic pollutants shall not exceed one-tenth (1/10th) of the 96-hour median tolerance limit based on available data. The concentration of toxic pollutants that are cumulative, persistent, or may otherwise exhibit chronic effects may be further limited on a case-by-case basis, where such data is available.

Available references to be used in determining toxicity limitations shall include, but not be limited to Quality Criteria for Water (Section 304(a)), Federal Regulations under Section 307, and Federal Regulations under Section 1412 of the Public Health Service Act as amended by the Safe Drinking Water Act (Pub. L. 93-523). The use of such information should be limited to that part applicable to the indigenous aquatic community found in the State of Mississippi.

8. The normal **pH of the waters** shall be 6.0 to 8.5 and shall not be caused to vary more than 1.0 unit; however, should the background pH be outside the 6.0 to 8.5 limits, it shall not be changed more than 1.0 unit unless after the change the pH will fall within the 6.0 to 8.5 limits, and the Commission determines that there will be no detrimental effect on stream usage as a result of the greater pH change.

9. The **maximum temperature rise** above natural temperatures shall not exceed 5 degrees F in streams, lakes and reservoirs nor shall the maximum water temperature exceed 90 degrees F, except that in the Tennessee River the temperature shall not exceed 86 degrees F. In lakes and reservoirs there shall be no withdrawals from or discharge of heated waters to the hypolimnion unless it can be shown that such discharge will be beneficial to water quality. In all waters the normal daily and seasonal temperature variations that were present before the addition of artificial heat shall be maintained. The discharge of any heated waste into any coastal or estuarine waters shall not raise temperatures more than 4 degrees F above natural during the period October through May nor more than 1.5 degrees F above natural for the months June through September. There shall be no thermal block to the migration of aquatic organisms. Requirements for zones of passage as referenced in Section I (8) shall apply. In addition to the general requirements of Section I (2), the temperature shall be measured at a depth of five feet in waters 10 feet or greater in depth; and for those waters less than 10 feet in depth, temperature criteria will be applied at mid-depth.

In those specific cases where natural conditions elevate the temperatures in excess of the limits expressed herein, Section I (3) shall apply on a case-by-case basis.

Section III. Specific Water Quality Criteria

1. Public Water Supply

Water in this classification is for use as a source of raw water supply for drinking and food processing purposes. The water treatment process shall be approved by the Mississippi State Board of Health. The raw water supply shall be such that after the approved treatment process, it will satisfy the regulations established pursuant to Section 1412 of the Public Health Service Act as amended by the Safe Drinking Water Act (Pub. L. 93-523). Waters that meet the Public Water Supply Criteria shall also be suitable for incidental recreational contact.

In considering the acceptability of a proposed site for disposal of bacterially-related wastewater in or near waters with this classification, the Permit Board shall consider the relative proximity of the discharge to water supply intakes.

a. **Bacteria.** Fecal coliform shall not exceed 2000/100 ml as a geometric mean (either MPN or MF count) based on at least five samples taken over a 30-day period nor exceed a maximum of 4000/100 ml in any one sample.

b. **Chlorides (C1).** There shall be no substances added which will cause the chloride content to exceed 250 mg/l in freshwater streams.

c. **Specific conductance.** There shall be no substances added to increase the conductivity above 500 micromhos/cm for freshwater streams.

d. **Dissolved solids.** There shall be no substances added to the waters which will cause the dissolved solids to exceed 500 mg/l for freshwater streams.

e. **Threshold odor.** There shall be no substances added which will cause the threshold odor number to exceed 24 (at 60 degrees C) as a daily average.

f. **Phenolic compounds.** There shall be no substances added which will cause the phenolic content to be greater than 0.001 mg/l (phenol).

g. **Radioactive substances.** There shall be no radioactive substances added to the waters which will cause the gross beta activity (in the known absence of Strontium-90 and alpha emitters) to exceed 1000 picocuries per liter at any time.

h. **Specific chemical constituents.** Considering Section II, 7, in no case shall the following concentrations (dissolved) be exceeded at any time.

Constituent	Concentration (mg/l)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium (hexavalent)	0.05
Cyanide	0.025
Fluoride	1.2
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.0
Selenium	0.01
Silver	0.05

2. Shellfish Harvesting Areas

Waters classified for this use for propagation and harvesting shellfish for sale or use as a food product. These waters shall meet the requirements set forth in the latest edition of the National Shellfish Sanitation Program, Manual of Operations, Part I, "Sanitation of Shellfish Growing Areas," published by the U.S. Public Health Service. Waters that meet the Shellfish Harvesting Area Criteria shall also be suitable for recreational purposes.

In considering the acceptability of a proposed site for disposal of bacterially-related wastewater in or near waters with this classification, the Permit Board shall consider the relative proximity of the discharge to shellfish harvesting beds.

a. **Bacteria.** The median fecal coliform MPN (Most Probable Number) of the water shall not exceed 14 per 100 ml, and not more than ten percent (10%) of the samples shall ordinarily exceed an MPN of 43 per 100 ml in those portions or areas most probably exposed to fecal contamination during most unfavorable hydrographic and pollutional conditions.

3. Recreation

The quality of waters in this classification are to be suitable for recreational purposes, including such water contact activities as swimming and water skiing. The waters shall also be suitable for use for which waters of lower quality will be satisfactory.

In considering the acceptability of a proposed site for disposal of bacterially-related wastewater in or near waters with this classification, the Permit Board shall consider the relative proximity of the discharge to areas of actual water contact activity.

a. **Bacteria.** Fecal coliform shall not exceed a geometric mean of 200 per 100 ml nor shall more than ten percent (10%) of the samples examined during any month exceed 400 per 100 ml.

b. **Specific conductance.** There shall be no substances added to increase the conductivity above 1000 micromhos/cm for freshwater streams.

c. **Dissolved solids.** There shall be no substances added to the water to cause the dissolved solids to exceed 750 mg/l as a monthly average value, nor exceed 1500 mg/l at any time for freshwater streams.

4. Fish and Wildlife

Waters in this classification are intended for fishing and for propagation of fish, aquatic life, and wildlife. Waters that meet the Fish and Wildlife Criteria shall also be suitable for incidental recreational contact.

a. **Bacteria**. Fecal coliform shall not exceed a geometric mean of 2000/100 ml, nor shall more than ten percent (10%) of the samples examined during any month exceed 4000/100 ml.

b. **Specific conductance**. There shall be no substances added to increase the conductivity above 1000 micromhos/cm for freshwater streams.

c. **Dissolved solids.** There shall be no substances added to the waters to cause the dissolved solids to exceed 750 mg/l as a monthly average value, nor exceed 1500 mg/l at any time for freshwater streams.

d. **Phenolic compounds.** There shall be no substances added which will cause the phenolic content to exceed 0.05 mg/l (phenol).

5. Ephemeral Stream

Waters in this classification do not support a fisheries resource and are not usable for human consumption or aquatic life. Ephemeral streams normally are natural watercourses, including natural watercourses that have been modified by channelization, that flow only in direct response to precipitation in the immediate locality and whose channels are normally above the groundwater table.

Waters in this classification shall be protective of wildlife and humans which may come in contact with the waters. Waters contained in ephemeral streams shall also allow maintenance of the standards applicable to all downstream waters.

a. Provisions 1 through 5 of Section II (**Minimum conditions** Applicable to All Waters) are applicable except as they relate to fish and other aquatic life.

b. **Dissolved oxygen.** The dissolved oxygen shall be maintained at an appropriate level to avoid nuisance conditions.

c. **Bacteria.** The Permit Board may assign bacterial criteria where the probability of a public health hazard or other circumstances so warrant.

Assignment of the Ephemeral Stream classification shall be made by the Permit Board after appropriate demonstration of physical and hydrological data. The Ephemeral Stream classification shall not be assigned where environmental circumstances are such that a nuisance or hazardous condition would result or public health is likely to be threatened. Alternate discharge points shall be investigated before the Ephemeral Stream classification is considered.

Section IV. Water Uses in Streams

All of the streams not specifically listed below shall be classified as Fish and Wildlife. Streams carrying other classifications are:

Waters	From	To	Classification
Tombigbee River Basin			
	From	*To*	
Chiwapa Reservoir		Pontotoc County	Recreation
Choctaw Lake		Choctaw County	Recreation
Davis Lake		Chickasaw County	Recreation
Lake Lamar Bruce		Lee County	Recreation
Lake Lowndes		Lowndes County	Recreation
Lake Monroe		Monroe County	Recreation
Lake Tom Bailey		Lauderdale County	Recreation
Luxapalila Creek	Miss-Ala State Line	Highway 50	Public Water Supply
Oktibbeha County Lake		Oktibbeha County	Recreation
Tombigbee State Park		Lee County	Recreation
Yellow Creek	Miss-Ala State Line	Luxapalila Creek	Public Water Supply
Yazoo River Basin			
	From	*To*	
Arkabutla Reservoir		Desoto-Tate Counties	Recreation
Chewalla Reservoir		Marshall County	Recreation
Enid Reservoir		Panola-Lafayette-Yalobusha Counties	Recreation
Grenada Reservoir		Grenada County	Recreation
Lake Dumas		Tippah County	Recreation
Lake Washington		Washington County	Recreation
Moon Lake		Coahoma County	Recreation
Sardis Reservoir		Panola-Lafayette-Counties	Recreation
Tallahatchie River	Sardis Reservior	U.S. Highway No. 51	Recreation
Tillatoba Lake		Yalobusha County	Recreation
Unnamed Drainage Ditch	Town of Arcola	Black Bayou	Ephemeral
Unnamed Drainage Ditch	Town of Beulah	Laban Bayou	Ephemeral
Unnamed Drainage Ditch	Farm Fresh Catfish (Hollandale)	Black Bayou	Ephemeral
Unnamed Drainage Ditch	Simmons Farm Raised Catfish (Yazoo County)	Lake George	Ephemeral
Unnamed Drainage Ditch	Town of Tunica	Whiteoak Bayou	Ephemeral
Wall Doxey State Park Reservoir		Marshall County	Recreation

Tennessee River Basin

	From	To	
Tennessee River	Miss-Ala State Line	Miss-Tenn State Line	Public Water Supply

North Independent Streams Basin

Horn Lake	Desoto County	Recreation

Pearl River Basin

	From	To	
Barnett	River Bend	Township Line	Public Water
Reservoir	bet. T7N & T8N	Supply	
Barnett	Township Line	Reservoir dam	Public Water
Reservoir	bet. T7N & T8N	Supply &	
	Recreation		
Bogue Chitto Creek	Ms Hwy 570	Ms. La. State Line	Recreation
Lake Columbia		Marion County	Recreation
Lake Dixie Springs		Pike County	Recreation
Lake Dockery		Hinds County	Recreation
Lake Jeff Davis		Jefferson Davis County	Recreation
Lake Mary Crawford		Lawrence County	Recreation
Lake Roosevelt		Scott County	Recreation
Lake Walthall		Walthall County	Recreation

Nebraska Department of Environmental Control

Title 118 - Ground Water Quality Standards and Use Classification

Revised Effective Date: January 11, 1988

Kay A. Orr
Governor

Chapter 2 – Intent and Applicability of Standards and Classification

001 The Ground Water Quality Standards and Use Classification are intended to be the foundation for other ground water regulatory programs. These Standards shall be implemented in conjunction with other regulatory programs. If other regulatory programs do not exist, these Standards alone may be used as the basis for remedial action of ground water contamination.

002 The ground water standards and ground water classifications shall apply to all ground waters of the State with the following exceptions:

002.01 Within an aquifer or a part of an aquifer that has been exempted through the Rules and Regulations of the Nebraska Oil and Gas Conservation Commission or through the Nebraska Department of Environmental Control's Title 122 - Rules and Regulations for Underground Injection and Mineral Production Wells. This exception will apply only for ground water contaminants directly related to the activity requiring exemption. If the exemption designation is removed, this exception will no longer apply.

002.02 As explained in 003 and 004 below.

003 The numerical standards of Chapter 4 are intended to be applied in regulatory programs administered by the Department. This does not imply that all ground waters in the State will be expected to meet these levels. When point source ground water pollution has occurred, the numerical standards shall be applied according to Chapter 10.

004 The numerical standards of Chapter 4 shall apply to all ground water classes of Chapter 7 except as provided below:

004.01 The numerical standards of Chapter 4 shall not apply to ground waters classified as GC unless any of the following situations occur:

004.01A If a condition exists which has impaired or will impair, in the Department's judgment, beneficial uses other than drinking water.

004.01B If public health or welfare are threatened.

004.01C If considered necessary by the Department to protect hydrologically connected ground waters or surface water beneficial uses (as assigned in Title 117 - Nebraska Water Quality Standards for Surface Waters of the State).

004.02 The numerical standards of Chapter 4 shall not apply within a discrete boundary for the pollutants being considered, under consideration, as may be determined under the remedial action provisions of Chapter 10 in the event of pollution.

Enabling Legislation: Neb. Rev. Stat. § 81-1505(1)(2)

Legal Citation: Title 118, Ch. 2, Nebraska Department of Environmental Control

Chapter 3 - Antidegradation Clause

001 It is the public policy of the State of Nebraska to protect and improve the quality of ground water for human consumption; agriculture, industry and other productive, beneficial uses; and to achieve the standards set out in Chapter 4 herein, wherever attainable. In determining whether such standards are attainable for any specific aquifer, the State should take into consideration environmental, technological, social and economic factors.

002 It is recognized that the existing quality of some ground water in Nebraska is better than the maximum contaminant levels set out in Chapter 4 herein as of the date on which these standards become effective. This existing high quality ground water will be maintained and protected.

003 In select cases the State may choose, after notice and hearing, to allow degradation os such high quality ground water where justified as a result of necessary and widespread economic or social development; provided however, that in no event may degradation of ground water quality interfere with or become injurious to existing water uses.

Enabling Legislation: Neb. Rev. Stat. §§ 81-1505(1)(2)

Legal Citation: Title 118, Ch. 3, Nebraska Department of Environmental Control

Chapter 4 - Narrative and Numerical Standards

001 The following narrative standards shall apply to ground waters in the State:

001.01 Wastes, toxic substances, or any other pollutant (alone or in combination with other pollutants) introduced directly or indirectly by human activity shall not be allowed to enter ground water:

001.01A If beneficial uses of ground water would be impaired; or

001.01B If beneficial uses of hydrologically connected ground waters or assigned uses of surface waters would be impaired.

001.02 Any pollutant introduced directly or indirectly by human activity that would impair beneficial uses of ground water due to unacceptable color, corrosivity, odor, or any other aesthetic characteristic shall not be allowed.

002 Numerical standards (maximum contaminant levels) for the parameters listed below shall apply to ground waters in the State in accordance with Chapters 2 and 3. Any substance introduced directly or indirectly by human activity shall not be allowed to enter ground water if one or more of the following numerical standards would be exceeded ("reserved" indicates that a standard will be promulgated for this parameter):

	Public Health Parameters	*Maximum Contaminant Level*
Inorganics:		
	Arsenic	0.05 mg/l
	Barium	1.00 mg/l
	Cadmium	0.010 mg/l
	Chromium	0.05 mg/l
	Flouride	4.00 mg/l
	Lead	0.05 mg/l
	Mercury	0.002 mg/l
	Nitrate-nitrogen	10.00 mg/l
	Selenium	0.01 mg/l
	Silver	0.05 mg/l
	Aluminum	(Reserved)
	Antimony	(Reserved)
	Molybdenum	(Reserved)
	Asbestos	(Reserved)
	Vanadium	(Reserved)
	Sodium	(Reserved)
	Nickel	(Reserved)
	Thallium	(Reserved)
	Beryllium	(Reserved)
	Cyanide	(Reserved)
Organics:		
	Endrin	0.0002 mg/l
	Lindane	0.004 mg/l
	Methoxychlor	0.1 mg/l
	Toxaphene	0.005 mg/l
	2, 4-D	0.1 mg/l
	2,3,5-TP Silvex	0.01 mg/l
	Total trihalomethanes	0.10 mg/l
	Trichloroethylene	0.005 mg/l
	Carbon tetrachloride	0.005 mg/l
	Vinyl chloride	0.002 mg/l
	1, 2-Dichloroethane	0.005 mg/l
	Benzene	0.005 mg/l
	1, 2-Dichloroethylene	0.007 mg/l
	1, 1, 1-Trichloroethane	0.20 mg/l
	p-Dichlorobenzene	0.075 mg/l
	Tetrachloroethylene	(Reserved)
	Methylene chloride	(Reserved)
	Chlorobenzene	(Reserved)
	Trichlorobenzene	(Reserved)
	trans-1,2-Dichloroethylene	(Reserved)
	cis-1,2-Dichloroethylene	(Reserved)
	Aldicarb	(Reserved)
	Chlordane	(Reserved)
	Dalapon	(Reserved)

Diquat	(Reserved)
Endothall	(Reserved)
Glyphosate	(Reserved)
Carbofuran	(Reserved)
Alachlor	(Reserved)
Epichlorohydrin	(Reserved)
Toluene	(Reserved)
Adipates	(Reserved)
2,3,7,8-TCDD (Dioxin)	(Reserved)
1,1,2-Trichloroethane	(Reserved)
Vydate	(Reserved)
Simazine	(Reserved)
PAH's	(Reserved)
PCB's	(Reserved)
Atrazine	(Reserved)
Phthalates	(Reserved)
Acrylamide	(Reserved)
Dibromochloropropane (DBCP)	(Reserved)
1,2-Dichloropropane	(Reserved)
Pentachlorophenol	(Reserved)
Pichloram	(Reserved)
Dinoseb	(Reserved)
Ethylene dibromide	(Reserved)
Dibromomethane	(Reserved)
Xylene	(Reserved)
Hexachlorocyclopentadiene	(Reserved)

Radionuclides:

Combined radium-226 and radium-228	5 pCi/l
Gross alpha particle activity (including radium-226 but excluding radon and uranium)	15 pCi/l
Gross beta particle activity	50 pCi/l
Uranium	(Reserved)
Radon	(Reserved)

Microbiology:

Total coliforms	(Reserved)

Other Parameters Affecting Use	*Maximum Contaminant Level*
Chloride	250 mg/l
Copper	1 mg/l
Foaming agents (Methylene-blue-active substances)	0.5 mg/l
Iron	0.3 mg/l
Manganese	0.05 mg/l
Sulfate	250 mg/l
Zinc	5 mg/l
pH	6.5-8.5

003 The numerical standards listed in 002 above are intended to protect beneficial uses of ground water. If the background level of a parameter is greater than the numerical standard, this shall not in and of itself prohibit the use of the ground water.

004 If the background level of a parameter is greater than the numerical standard listed in 002 above, the background level shall be used as the numerical standard.

Enabling Legislation: Neb. Rev. Stat. § 81-1505(1)(2)

Legal Citation: Title 118, Ch. 4, Nebraska Department of Environmental Control

Chapter 5 - Basis for Contaminant Levels and Measurements

001 Rationale for the maximum contaminant levels stated in Chapter 4 is based on the following references:

001.01 National Interim Primary Drinking Water Regulations. 40 C.F.R. Part 141 (1986).

001.02 National Secondary Drinking Water Regulations. 40 C.F.R. Part 143 (1986).

001.03 Interim Primary Drinking Water Regulations: Promulgation of Regulations on Radionuclides. 40 C.F.R. §§141.15, 141.16 (1986)

001.04 Nebraska Safe Drinking Water Act, Neb. Rev. Stat. § 71-5301 et seq.

002 The following resources contain information that may be used to set additional contaminant levels or to set cleanup levels:

002.01 Water Quality Criteria. California Water Quality Control Board, 1963.

002.02 Water Quality Criteria, 1972. U.S. Environmental Protection Agency, March 1973.

002.03 Quality Criteria for Water. U.S. Environmental Protection Agency, July 1976.

003 Testing procedures are to be conducted in accordance with:

003.01 Methods for Chemical Analysis of Water and Wastes. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency. EPA-600/4-79-020. 1979.

003.02 Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency. EPA-600/4-82-057. 1982.

003.03 Standard Methods for the Examination of Water and Wastewater. American Public Health Association, American Water Works Association, and Water Pollution Control Federation. 16th Edition, 1985.

003.04 Test Methods for Evaluation Solid Waste: Physical/Chemical Methods. U.S. Environmental Protection Agency. EPA SW-846. 2nd Edition, 1984.

004 Ground water sampling shall be conducted according to the Procedure Manual of the Department's Support Services Division, Technical Services Section, or other methods approved by the Department.

Enabling Legislation: Neb. Rev. Stat. § 81-1505(1)(2)

Legal Citation: Title 118, Ch. 5, Nebraska Department of Environmental Control

Chapter 6 - Ground Water Beneficial Uses

001 The beneficial uses of ground water in the State shall be protected from impairment. These include existing or potential use for drinking water, irrigation, livestock watering, industrial and commercial purposes, maintaining assigned surface water uses, and other beneficial uses.

002 Although all beneficial uses included in 001 above shall be protected, the highest and most sensitive beneficial use of ground water is drinking water. Ground water that is suitable for drinking water is usually suitable for other beneficial uses. Therefore, protecting ground water for drinking water use normally protects it for all beneficial uses.

003 The Department will protect the beneficial uses of ground water regardless of its quality.

Enabling Legislation: Neb. Rev. Stat. § 81-1505(1)(2)

Legal Citation: Title 118, Ch. 6, Nebraska Department of Environmental Control

Chapter 7 - Ground Water Classification

001 All ground waters of the State shall be classified based on existing and potential drinking water use.

002 Class assignment, where possible, shall be based on the background conditions or beneficial use of the ground water prior to a pollution event.

003 All ground waters of the State shall be classified by the Department into one of the following classes:

> **003.01** Class GA. Ground water assigned to this class is currently being used as a public drinking water supply or is proposed to be used as a public drinking water supply. This includes:
>
> **003.01A1** An area, based on local hydrogeologic conditions around a well or wellfield, defined by the Nebraska Department of Health, the Department, or the local water system involved (as approved by the Nebraska Department of Health);
>
> **003.01A2** An area at least as large as and encompassing the entirety of that described by 003.01A3. below designated through local ordinances, if 003.01A1. above has not been determined; or
>
> **003.01A3** The area within a 1,000-foot radius of a single well or the area within a 1,000-foot distance of the perimeter of a wellfield, if neither 003.01A1. nor 003.01A2. above has been determined.
>
> **003.01B** Ground water represented by an area of overlying land which has been zoned or purchased by a local government for the purpose of developing a public drinking water supply well or wellfield.

003.02 Class GB. Ground water assigned to this class is currently being used as a private drinking water supply or has the potential for being used as a public or private drinking water supply but currently cannot be classified as GA. Class GB shall be assigned to all ground waters in the State except those assigned to Classes GA and GC.

003.03 Class GC. Ground water assigned to this class is not being used, and has little or no potential for being used, as a public or private drinking water supply. Class GC shall be assigned on a case-by-case basis as the necessary information becomes available and shall include, but not be limited to:

003.03A Ground water with poor natural or background quality compared to the numerical standards of Chapter 4. Class GC(R), a subset of Class GC, shall be assigned to certain portions of this ground water if the Department determines that restoration or cleanup may be appropriate, pursuant to the provisions of Chapter 10, to allow for attainment of future beneficial uses.

003.03B Ground water in which hydrogeologic conditions make development of a public or private drinking water supply unlikely. Such information as depth to ground water and the transmissivity and areal extent of the aquifer may be considered.

004 All public drinking water supply wells as identified by the Nebraska Department of Health shall be used in Class GA determination. As of the effective date of these regulations, Class GC has not been assigned to any ground waters in the State.

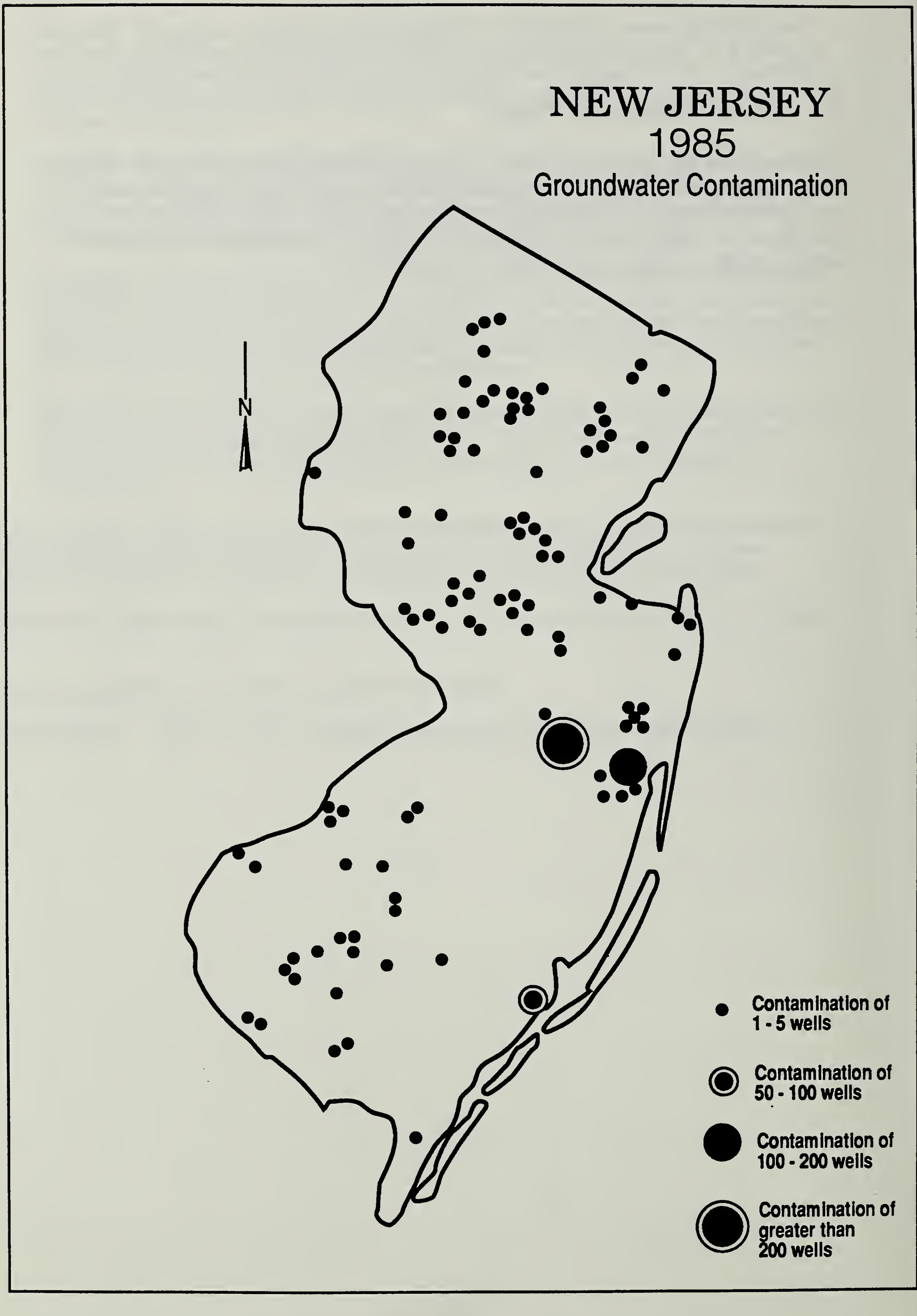
005 Ground water may be reclassified according to the procedures set forth in Chapter 8.

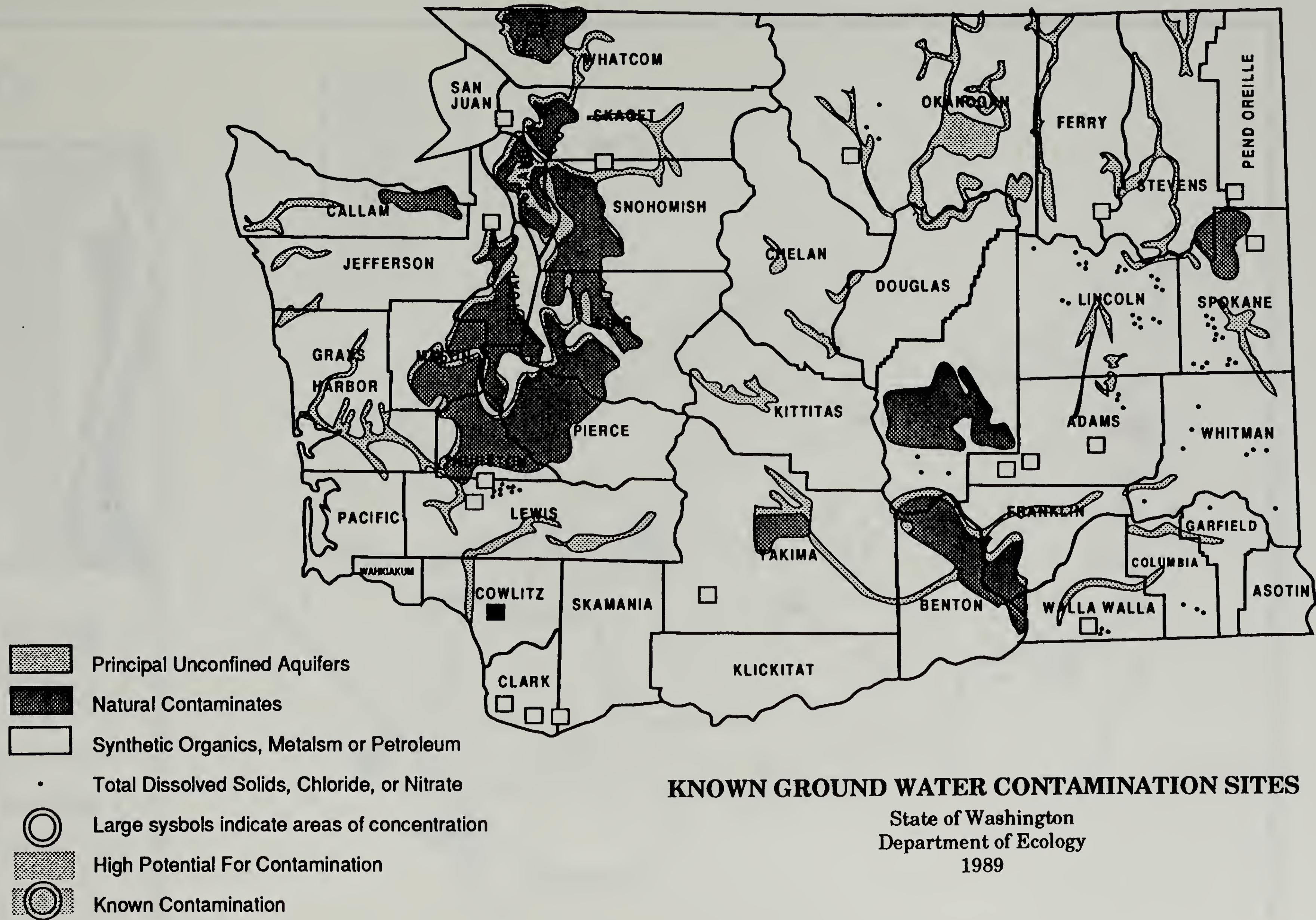
Enabling Legislation: Neb. Rev. Stat. § 81-1505(1)(2)

Legal Citation: Title 118, Ch. 7, Nebraska Department of Environmental Control

B. Water Resource Maps

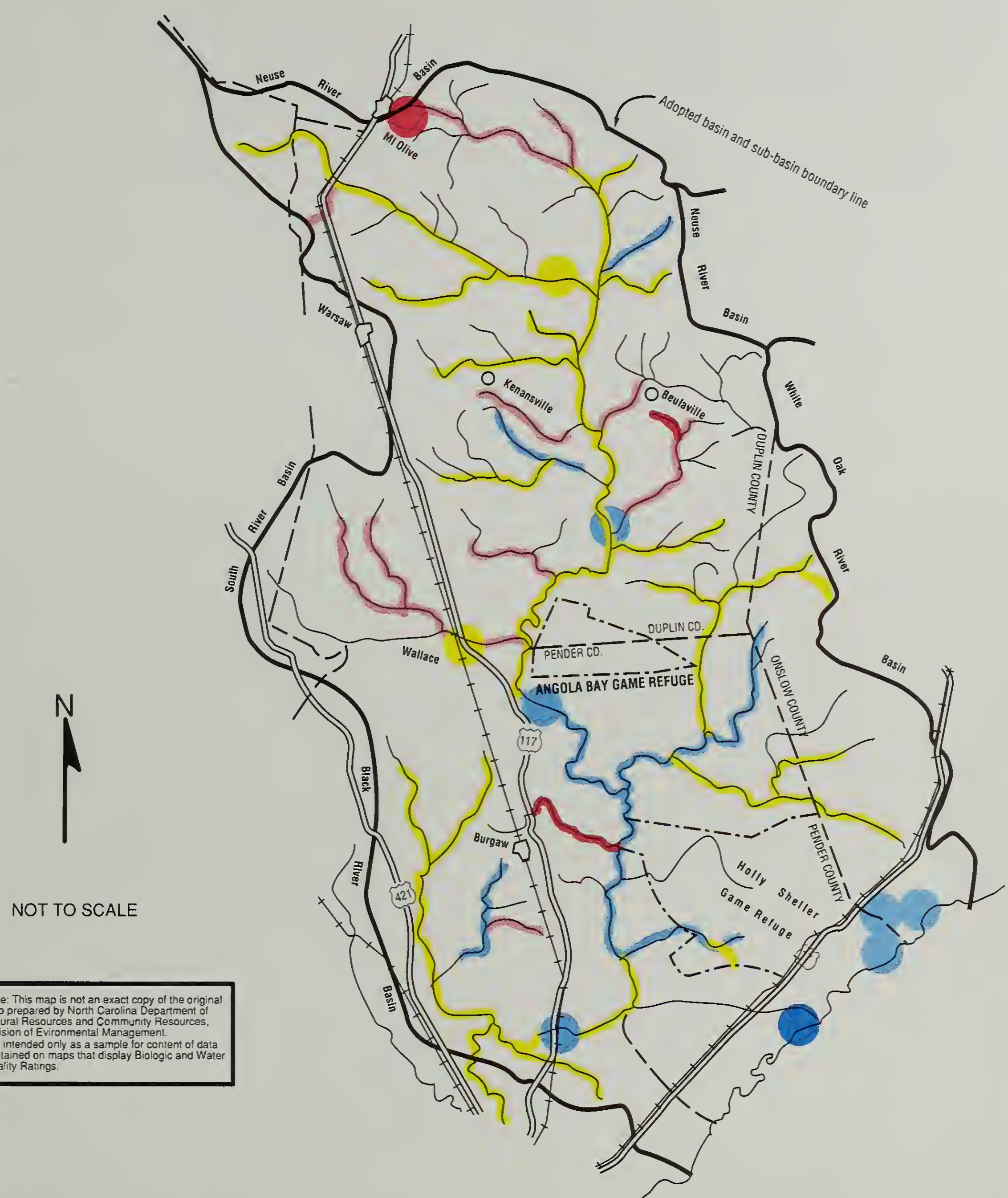
The maps on the pages that follow present different methods for conveying water quality information. They show current conditions of surface water and ground water on a regional and on a statewide basis. All maps can be compared to state criteria, standards, and use classifications to determine water quality conditions that relate to regulations.


NEW JERSEY
1985
Groundwater Contamination
N
Contamination of 1 - 5 wells
Contamination of 50 - 100 wells
Contamination of 100 - 200 wells
Contamination of greater than 200 wells



KNOWN GROUND WATER CONTAMINATION SITES

State of Washington
Department of Ecology
1989



Note: This map is not an exact copy of the original map prepared by North Carolina Department of Natural Resources and Community Resources, Division of Evironmental Management.
It is intended only as a sample for content of data contained on maps that display Biologic and Water Quality Ratings.

Water Quality

Division of Environmental Management

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT

CAPE FEAR RIVER BASIN

BIOLOGIC AND WATER QUALITY RATINGS (MAP 2)

BIOLOGIC RATING	WATER QUALITY INDEX RATING
EXCELLENT	EXCELLENT (0 - 20)
GOOD	GOOD (21 - 40)
GOOD - FAIR	GOOD - FAIR (41 - 60)
FAIR	FAIR (61 - 80)
POOR	POOR (81 - 100)

BIOLOGIC RATINGS are based on numbers and kinds of living organisms found in the stream
WATER QUALITY INDEX RATINGS are based on the presence or absence of chemical or physical pollutants in the stream.

USDA-SCS-NATIONAL CARTOGRAPHIC CENTER, FT. WORTH, TX.-1989

Section III – Effects of Land Use, Management, and Conservation Practices on Water Resources

A. The Effects Of Land Use and Management On Water Resources

These tables display the effects of land use and management on water resources. All tables do not apply to all states. Appropriate modifications will be needed to conform to individual state conditions and needs.

The effects (i.e. low, moderate, high) are estimates based on research data, where available, and field experience. The tables should not be considered precise. They do, however, provide a relative indication of the effects of various land uses on water resources.

Table 1a. *The effects of land use management on water resources*
Semiarid

Land Use:	Cropland			Cropland			Hayland / Pastureland	Rangeland	
Moisture / Management System:	Irrigated-low efficiency [19]			Nonirrigated			Nonirrigated; Fair management	Excellent to good	Fair to poor
Soil:	Clay	Silt	Sand	Clay	Silt	Sand	All	All	All
Water Budget:									
Runoff	High	Moderate	Low	Low	Low	Low	Low[11]	Low	Mod-High[13]
Deep Percolation	Low	Moderate	High	Low	Moderate	Moderate	Low-Mod	Low	Low
Sediment Yield	Varies w/ Slope M-H	High	Low	Low-Mod[9]	High[9]	Low[9]	Low	Low	Mod-High
Phosphorus Movement[15]:									
Attached Phosphorus	High	High	Low	Low	Low	Low	Low	Low	Mod-High
Dissolved Phosphorus	Low	Low	Moderate	Low	Low	Low	Low	Low	Low
Nitrogen Movement:									
Adsorbed and Complexed[17] Nitrogen	High	High	Low	Low	Low	Low	Low	Low	Mod-High
Soluble Nitrogen	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Low
Pesticide Movement[16]:									
Strongly Adsorbed; Limited Mobility	High on Sediment	High on Sediment	Low	Low	Low	Low	Low	Low	Mod-High
Weakly Adsorbed; Mobility in:									
Ground Water	Low	Moderate	High	Low	Low	Low	Low	Low	Low-High[7]
Surface Water	Rel.High	Moderate	Low	Low	Low	Low	Low	Low	Mod-High
Organic Material Effects:									
Microbes	Moderate[1]	Moderate[1]	Low[1]	Moderate[1]	Moderate[1]	Moderate[1]	Moderate[12]	Low[12]	Low[12]
Organic Matter	Moderate[1]	Moderate[1]	Low[1]	Moderate[1]	Moderate[1]	Moderate[1]	Low-Mod	Low	Low
Dissolved Oxygen [5]	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased	No sign Effect	No sign. Effect	No sign. Effect
Salinity:									
Soil	Mod-High	Moderate	Low	Low	Low	Low	Low	Low	Low
Ground Water	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Low	Low
Surface Water	Moderate[2]	Moderate[2]	Moderate[2]	Moderate[2,6]	Moderate[2,6]	Moderate[2,6]	Low	Low	Low

Table 1b. ***The effects of land use and management on water resources***
Humid

Land use:	Cropland			Cropland			Hayland/Pastureland	Rangeland	
Moisture/management system:	Irrigated-low efficiency [19]			Nonirrigated			Nonirrigated; Fair management	Excellent to good	Fair to poor
Soil:	Clay	Silt	Sand	Clay	Silt	Sand	All	All	All
Water Budget:									
Runoff	High	High	Moderate[3]	High	High	Moderate	Low	Low	Mod-High[13]
Deep Percolation	Moderate	High	High	Low-Mod	Mod-High	High	Low	Low	Low
Sediment Yield	Varies w/ Slope M-H	High	Mod-High[3]	Moderate	High	Low[3]	Low	Low	Moderate
Phosphorus Movement[15]:									
Attached Phosphorus	High	High	Low	High	High	Low to Moderate	Low	Low	Moderate
Dissolved Phosphorus	Low	Low-Mod	Moderate	Low	Low	Low	Low	Low	Low
Nitrogen Movement:									
Adsorbed and Complexed[17] Nitrogen	High	High	Low	High	High	Low-Mod	Low	Low	Moderate
Soluble Nitrogen	Moderate	High	High	Moderate	Moderate	High	Low	Low	Low
Pesticide Movement[16]:									
Strongly Adsorbed; Limited Mobility	High	High	Low	High on Sediment	High on Sediment	Low	Low	Low	Moderate
Weakly Adsorbed; Mobility in:									
Ground Water	Low	Mod-High	High	Low	Moderate	High	Low	Low	Moderate
Surface Water	High	Mod-High	Moderate	Low-Mod	Mod-High	Moderate	Low	Low	Low
Organic Material Effects:									
Microbes	Moderate[1]	Moderate[1]	Moderate[1]	High[1]	Moderate[1]	Moderate[1]	Moderate[12]	Moderate[12]	Low[12]
Organic Matter	Moderate[1]	Moderate[1]	Moderate[1]	Moderate[1]	Moderate[1]	Moderate[1]	Low	Low	Low
Dissolved Oxygen[5]	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased	No Effect	No Effect	No Effect
Salinity									
Soil	Low-Mod	Low	Low	Low	Low	Low	Low	Low	Low
Ground Water	Low	Low	Low	Low	Low	Low	Low	Low	Low
Surface Water	Low[2]	Low	Low[2]	Low	Low	Low	Low	Low	Low

Table 1c. *The effects of land use and management on water resources*
Arid[18]

Land use:	Cropland			Rangeland	
Moisture/managemant system:	Irrigated-low efficiency			Excellent to good	Fair to poor
Soil:	Clay	Silt	Sand	All	All
Water Budget:					
Runoff	High	Moderate	Low	Low	Mod-High[13]
Deep Percolation	Moderate	Moderate	High	Low	Low
Sediment Yield	Varies w/ Slope M-H	High	Low	Low[13]	Mod-High
Phosphorus Movement[15]:					
Attached Phosphorus	Mod-High	High	Low	Low	Moderate
Dissolved Phosphorus	Low	Low	Moderate	Low	Low
Nitrogen Movement:					
Adsorbed and Complexed[17] Nitrogen	Mod-High	High	Low	Low	Moderate
Soluble Nitrogen	Moderate	Moderate	High	Low	Low
Pesticide Movement[16]:					
Strongly Adsorbed; Limited Mobility	High on Sediment	High on Sediment	Low	Low	Mod-High
Weakly Adsorbed; Mobility in:					
Ground Water	Low	Moderate	High	Low	Low-High[1,7]
Surface Water	Rel. High for Pest.	Moderate	Low	Low	Moderate to High
Organic Material Effects:					
Microbes	Moderate[1]	Moderate[1]	Low[1]	Low	Low[12]
Organic Matter	Moderate[1]	Moderate[1]	Low[1]	Low	Low
Dissolved Oxygen[5]	Decreased	Decreased	Decreased	No Effect	No Effect
Salinity					
Soil	High	Moderate	Low	Low	Low
Ground Water	Moderate[2]	Moderate[2]	Moderate[2]	Low	Low
Surface Water	Low	Mod-High	Moderate	Low	Low

Table 1d. *The effects of land use and management on water resources* Snow melt dominated [8]

Land use:	Cropland Hayland/pastureland			Rangeland		
Moisture/management system:	Nonirrigated			Nonirrigated fair management	Excellent to good	Fair to poor
Soil:	Clay	Silt	Sand	All	All	All
Water Budget:						
Runoff	High[4]	High[4]	Moderate[4]	Low[11]	Low	Mod-High[13]
Deep Percolation	Low[4]	Moderate[4]	High[4]	Low-Mod	Low	Low
Sediment Yield	High[4]	High[4]	Low	Low	Low	Mod-High
Phosphorus Movement[15]:						
Attached Phosphorus	High	High	Moderate	Low	Low	Mod-High
Dissolved Phosphorus	Moderate	Low	Low	Low	Low	Low
Nitrogen Movement:						
Adsorbed and Complexed[17] Nitrogen	High	High	Low	Low	Low	Mod-High
Soluble Nitrogen (Nitrate)	Moderate	Moderate	Moderate	Low	Low	Low
Pesticide Movement[16]:						
Strongly Adsorbed; Limited Mobility	Low Sediment	Low Sediment	Low	Low	Low	Mod-High
Weakly Adsorbed; Mobility in:						
Ground Water	Low	Low to Moderate	Moderate	Low	Low	Low-High[7]
Surface Water	Low	Moderate	Low	Low	Low	Mod-High
Organic Material Effects:						
Microbes	Moderate[1]	Moderate[1]	Moderate[1]	Moderate[12]	Low[12]	Low[12]
Organic Matter	Moderate[1]	Moderate[1]	Moderate[1]	Low-Mod	Low	Low
Dissolved Oxygen[5]	Decreased	Decreased	Decreased	No sign. Effect	No sign. Effect	No sign. Effect
Salinity						
Soil Low	Low	Low	Low	Low	Low	
Ground Water	Low-Mod[6]	Low-Mod[6]	Low-Mod[6]	Low	Low	Low
Surface Water	Low-Mod[2,6]	Low-Mod[2,6]	Low-Mod[2,6]	Low	Low	Low

Table 1e. *The effects of land use and management on water resources*
All climates

Land use:	Woodland	Fruits, nuts vineyards	Farmstead
Moisture/management system:	Production only, not harvest, fair	All	All
Soil:		All	
Water Budget:			
Runoff Low	Low	Mod-High	
Deep Percolation	Low	Low	Low
Sediment Yield	Low[11]	Low to High	Low
Phosphorus Movement[15]:			
Attached Phosphorus	Low[14]	Low to High	Low to High
Dissolved Phosphorus	Low[14]	Low to High	Low to High
Nitrogen Movement:			
Adsorbed and Complexed[17] Nitrogen	Low[14]	Low to High	Low to High
Soluble Nitrogen	Low[14]	Low to High	Low to High
Pesticide Movement[16]:			
Strongly Adsorbed; Limited Mobility	Low[14]	Low to High	Low to High
Weakly Adsorbed; Mobility in:			
Ground Water	Low[14]	Low to High	Low to High
Surface Water	Low[14]	Low to High	Low to High
Organic Material Effects:			
Microbes	Low	Low	Low to High
Organic Matter	Moderate	Low	Low to High
Dissolved Oxygen[5]	No Effect	No Effect	Low to High
Salinity			
Soil	Low	Low	Low
Ground Water	Low	Low	Low
Surface Water	Low	Low	Low

Footnote No.	
1	Greater concentrations of pathogens may occur where animal wastes are used. The pathogens are primarily a problem with surface water. Pathogens may be a hazard to ground water quality where special geologic conditions exist, such as karst limestone terrains, shallow soils overlying fractured rock, and coarse-grained soils over shallow aquifers.
2	Surface water in areas overlying salt-bearing rocks may be affected by interflow surfacing to surface or subsurface drain levels, springs, and saline seeps; and through capillary activity in areas with high water tables.
3	Sediment yields from sandy soils are principally the result of concentrated flow. These runoff characteristics are influenced by interbedded clay horizons, soil pans, high water tables, and other environmental factors.
4	Water quality effects are concentrated during periods of snow melt and thawing of the soil surface.
5	Dissolved oxygen decreases with increased temperature of surface water from sun warming, as well as from organic loading. Nutrient effects from animal wastes are considered in the nutrient portions of this table.
6	Salinity in ground and surface water, associated with salt-bearing rocks is usually not a consideration in humid areas.
7	Macropores, such as dessication cracks, joints, piping voids, root channels, and worm burrows will increase the downward movement of chemicals and other substances.
8	A snow melt dominated climate is where a significant portion of annual runoff occurs during the period when snow is melting.
9	Sediment yields may be seasonally higher during periods when precipitation occurs on thawing soil, especially where residue is limited.
10	Conditions may change significantly where irrigation is used and crop water management is practiced.

Footnote No.	
11	Runoff and related conditions are estimated on the basis of fair hydrologic conditions on hydrologic group B and C soils. Interpretive concepts should be adjusted where other hydrologic or management conditions are present.
12	Values may be higher where animals have direct access to watercourses.
13	Values may increase depending on slope, soil depth, and other environmental factors.
14	Considerable variation among seasons may exist, depending on growth stage, application of some pesticide controls, and harvest and management operations.
15	The labile fraction of sediment (or attached) Phosphorus (P) and dissolved P which are readily transported by water, constitute the total P fraction available to plants.
16	Pesticides with high partitioning coefficients have a greater potential to move with the sediment (attached). Pesticides with lower partitioning coefficients are more weakly adsorbed, and may move more readily dissolved in water.
17	Adsorbed and complexed (attached) nitrogen (N) include ammoniacal N and various organic N compounds which are adsorbed to sediment and organic matter. Organic N compounds increase with an increase in organic matter content in the soil. Soils with greater clay content and fine silt content bind more ammonium. The inorganic forms of nitrite and nitrate are completely water soluble and they move faster with water.
18	Hayland and pastureland, where found in an arid climate, will usually require irrigation. For the effects of these land uses on water resources, consult the semiarid table and project the nonirrigated semiarid effects into irrigated arid effects.
19	Low efficiency can represent high deep percolation losses in conjunction with low runoff; low deep percolation in conjunction with high runoff; or the combination of high deep percolation as well as high runoff. The latter condition is represented in these tables.

B. Conservation Practice Standards

Conservation practice standards establish the minimum level of acceptable quality for planning, designing, installing, operating, and maintaining conservation practices. Associated with the standards are the specifications that describe requirements necessary to install conservation practices so that they function properly. Specifications are the documents that are provided to contractors to guide them during practice installation.

In this section are provided two national level conservation practice standards, "Subsurface drain" number 606 and "Terrace" number 600. There are about 150 national standards. A "water resource supplement" has been proposed for all of the standards that affect or can be effected by water. The supplements are included as the last page of each of the standards included in the section.

The standards and associated specifications are included in Section IV of all SCS Field Office Technical Guides (FOTG).

Subsurface Drain (ft)

Definition

A conduit, such as tile, pipe, or tubing, installed beneath the ground surface to collect and/or convey drainage water.

Scope

This standard applies to the design and installation of conduits placed beneath the surface of the ground to provide drainage.

Purpose

To improve the soil environment for vegetative growth by regulating the water table and ground water flow; intercept and prevent water movement into a wet area; relieve artesian pressures; remove surface runoff; facilitate leaching of saline and alkali soils; serve as an outlet for other subsurface drains; regulate and control ground water for subirrigated areas or waste disposal areas; collect ground water for beneficial uses; remove water from around buildings, roads, airports, play areas, and other physical improvements; and regulate water to control health hazards caused by liver fluke, flies, or mosquitoes.

Conditions where practice applies

This practice applies to areas having a high water table where benefits of lowering or controlling ground water or surface runoff justify installing such a system.

This standard applies to areas suitable for the intended use after installation of required drainage and other conservation practices. The soil shall have enough depth and permeability to permit installation of an effective and economically feasible system. The drainability and treatment of saline and alkali soils shall be considered where this is a problem.

In areas where an outlet is available, either by gravity flow or by pumping, the outlet shall be adequate for the quantity and quality of effluent to be disposed. Consideration shall be given to possible damages above or below the point of discharge that might involve legal actions under state laws.

Design criteria

The design and installation shall be based on adequate surveys and investigations.

Capacity. The required capacity shall be determined by one or more of the following:

1. Application of a locally tried and proven drainage coefficient to the acreage drained. Include added capacity required to dispose of surface water entering through inlets.
2. Yield of ground water based on the expected deep percolation of irrigation water from the overlying fields, including the leaching requirement.
3. Survey and comparison of the site with other similar sites where subsurface drain yields have been measured.
4. Measurement of the rate of subsurface flow at the site during a period of adverse weather and ground water conditions.
5. Application of Darcy's law to lateral or artesian subsurface flow.
6. Estimates of lateral or artesian subsurface flow.

Size. The size of subsurface drains shall be computed by applying Manning's Formula. The size shall be based on the required capacity and computed by using one of the following assumptions:

1. The hydraulic gradeline parallel to the bottom grade of the subsurface drain with the conduit flowing full at design flow.
2. The conduit flowing part full where a steep grade or other conditions require excess capacity.
3. Conduit flowing under pressure with hydraulic gradeline set by site conditions on a grade that differs from that of the subsurface drain. This procedure shall be used only if surface water inlets or nearness of the conduit to outlets with fixed water elevations permit satisfactory estimates of hydraulic pressure and flows under design conditions.

All subsurface drains shall have a nominal diameter that equals or exceeds 3 in. (76 mm).

Depth, spacing, and location. The depth, spacing, and location of the subsurface drain shall be based on site conditions, including soils, topography, ground water conditions, crops, land use, outlets, and saline or alkaline conditions.

The minimum depth of cover over subsurface drains in mineral soils shall be 2 ft (0.6 m). This minimum depth shall apply to normal field levels and may exclude sections of line near the outlet or sections laid through minor depressions where the conduit is not subject to damage by frost action or equipment travel.

The minimum depth of cover in organic soils shall be 2.5 ft (0.76 m) for normal field levels, as defined above, after initial subsidence. Structural measures shall be installed if it is feasible to control the water table level in organic soils within the optimum range of depths.

Minimum velocity and grade. In areas where sedimentation is not a hazard, the minimum grades shall be based on site conditions and a velocity of not less than 0.5 ft/s (0.15 m/s). If a hazard exists, a velocity of not less than 1.4 ft/s (0.43 m/s) shall be used to establish the minimum grades if site conditions permit. Otherwise, provisions shall be made for preventing sedimentation by use of filters or by collecting and periodically removing sediment from installed traps, or by periodically cleaning the lines with high-pressure jetting systems or cleaning solutions, as specified in the plans.

Maximum grade and protection. On sites where topographic conditions require that drain lines be placed on steep grades and design velocities will be greater than indicated under "Maximum velocity without protection," special measures shall be used to protect the conduit. These measures shall be specified for each job according to the particular conditions of the job site. The protective measures shall include one or more of the following:

1. Selecting rigid butt end pipe or tile with straight smooth sections and square ends to obtain tight fitting joints.
2. Wrapping open joints of the pipe or tile with tar-impregnated paper, burlap, or special fabric-type filter material.
3. Placing the conduit in a sand and gravel envelope or binding with the least erodible soil available.
4. Sealing joints or using a watertight pipe or nonperforated continuous tubing.
5. Enclosing continuous perforated pipe or tubing with fabric-type filter material or properly graded sand and gravel.

Maximum velocity without protection. Velocities by soil texture are:

Soil texture	Velocity	
	ft/s	*m/s*
Sand and sandy loam	3.5	1.0
Silt and silt loam	5.0	1.5
Silty clay loam	6.0	1.8
Clay and clay loam	7.0	2.1
Coarse sand or gravel	9.0	2.7

Materials. Subsurface drains include conduits of clay, concrete, bituminized fiber, metal, plastic, or other materials of acceptable quality.

The conduit shall meet strength and durability requirements of the site. All conduits shall meet or exceed the minimum requirements indicated in "Specifications of Materials."

Foundation. If soft or yielding foundations are encountered, they shall be stabilized and the lines shall be protected from settlement by adding gravel or other suitable materials to the trench, by placing the conduit on a plank or other rigid supports, or by using long sections of perforated or watertight pipe having adequate strength to insure satisfactory subsurface drain performance.

Loading. The allowable loads on subsurface drain conduits shall be based on the trench and bedding conditions specified for the job. A factor of safety of not less than 1.5 shall be used in computing the maximum allowable depth of cover for a particular type of conduit.

Heavy-duty corrugated plastic drainage tubing shall be specified if the soil is rocky, if cover over the tubing is expected to exceed 10 ft (3 m), or trench widths are expected to exceed 2 ft (0.6 m). (This refers to trench widths in the area of the tubing and at least 1 ft (0.3 m) above the top of the tubing.)

Filters and filter material. Suitable filters shall be used around conduits if they are needed because of site conditions to prevent sediment accumulation in the conduit. The need for a filter shall be determined by the characteristics of the soil materials at drain depth and the velocity of flow in the conduit.

Not less than 3 in. (76 mm) of filter material shall be used for sand-gravel filters. The filter shall be designed to prevent the material in which the installation is made from entering the conduit. Not more than 10 percent of the filter material shall pass the No. 60 sieve.

Artificial fabric or mat-type filter materials may be used, provided that the effective opening size, strength, durability, and permeability are adequate to constantly filter the soil to protect subsurface drain operation throughout the expected life of the system.

Envelopes and envelope material. Envelopes shall be used around subsurface drains if they are needed for proper bedding of the conduit or to improve the characteristics of flow of ground water into the conduit.

Materials used for envelopes do not need to meet the gradation requirements of filters, but they shall not contain materials that will cause an accumulation of sediment in the conduit or that will render the envelope unsuitable for bedding of the conduit. Envelope materials shall consist of sand-gravel, organic, or other compressible material. Sand-gravel envelopes shall all pass a 1½ in. (38.1 mm) sieve; 90 to 100 percent shall pass a ¾ in. (19 mm) sieve; and not more than 10 percent shall pass a No. 60 sieve. Where organic or other compressible materials are used, they shall be used only around a rigid wall conduit and above the centerline of flexible tubing. All organic or other compressible material shall be of a type that will not readily decompose.

Placement and bedding. All subsurface drains, whether flexible conduit such as plastic or bituminized fiber or rigid conduits such as clay or concrete, shall be laid to a neat line and grade. The conduit shall be placed and bedded as described in ASTM-F-449, "Standard Recommended Practice for Subsurface Installation of Corrugated Thermoplastic Tubing for Agricultural Drainage or Water Table Control," except that:

1. Rigid drainage conduits, such as clay or concrete drain tile, do not need the 90 degree V-groove in the trench bottom.
2. The V-groove shall not be used for flexible conduits exceeding 8 in. (203 mm) in diameter, because the void under the conduit will create a potential path for soil erosion. A semicircular or trapezoidal groove shaped to fit the conduit shall be used for flexible conduits exceeding 8 in. (203 mm) in diameter.

An alternative method for placing and bedding all specified sizes of corrugated thermoplastic tubing is to place the tubing in accordance with ASTM-F-449, paragraph 8.6-Blinding, with the following additional requirements:

1. Compact bedding material to the top of the tubing.
2. Bedding material should be a minimum depth of 6 in. (152 mm) over the tubing.

Auxiliary structures and protection. Structures installed in drain lines must not unduly impede the flow of water in the system. Their capacity shall be no less than that of the line or lines feeding into or through them. The use of internal couplers for corrugated plastic tubing shall be allowed.

If the drain system is to carry surface water flow, surface water inlets shall have a capacity of no less than that required to provide the maximum design flow in the drain line or lines.

The capacity of a relief well system shall be based on the flow from the aquifer, the well spacing, and other site conditions and shall be adequate to lower the artesian waterhead to the desired level.

Junction boxes, manholes, catch basins, and sand traps shall be accessible for maintenance. A clear opening of not less than 2 ft (0.6 m) shall be provided in either circular or rectangular structures.

The size of relief wells is generally based on the available equipment rather than on hydraulic consideration. Such wells shall not be less than 4 in. (100 mm) in diameter.

The drain system shall be protected against velocities exceeding those provided under "Maximum velocity without protection" and against turbulence created near outlets, surface inlets, or similar structures. Continuous or closed-joint pipe shall be used in drain lines adjoining the structure where excessive velocities will occur.

Junction boxes shall be installed if more than two main drains join or if two main drains join at different elevations.

If surface water is to be admitted to subsurface drains, inlets shall be designed to exclude debris and prevent sediment from entering the conduit. Lines flowing under pressure shall be designed to withstand the resulting pressures and velocity of flow. Auxiliary surface waterways shall be used where feasible.

If not connected to a structure, the upper end of each subsurface drain line shall be capped with a tight-fitting cap of the same material as the conduit or other durable materials.

The outlet shall be protected against erosion and undermining of the conduit, against entry of tree roots, against damaging periods of submergence, and against entry of rodents or other animals into the subsurface drain. A continuous section of pipe without open joints or perforations shall be used at the outlet end of the line and shall discharge above the normal elevation of low flow in the outlet ditch. Corrugated plastic tubing is not suitable for the outlet section.

Continuously submerged outlets shall be permitted for water table control in organic and sandy soils if planned and designed according to the standards for regulating water in drainage systems (554).

The outlet pipe and its installation shall conform to the following requirements:

1. If burning vegetation on the outlet ditch bank is likely to create a fire hazard, the material from which the outlet pipe is fabricated shall be fire resistant. If the likelihood is great, the outlet pipe shall be fireproof.
2. Two-thirds of the pipe shall be buried in the ditch bank, and the cantilever section shall extend to the toe of the ditch side slope or the side slope shall be protected from erosion. The minimum length of the pipe shall be 8 ft (2.4 m).
3. If ice or floating debris may damage the outlet pipe, the outlet shall be recessed to the extent that the cantilevered part of the pipe will be protected from the current in the ditch.
4. Headwalls used for subsurface drain outlets shall be adequate in strength and design to avoid washouts and other failures.

Watertight conduits strong enough to withstand the expected loads shall be used if subsurface drains cross under irrigation canals or other ditches. Conduits under roadways shall be designed to withstand the expected loads. Shallow subsurface drains through depressed or low areas and near outlets shall be protected from damage by farm machinery and other equipment and freezing and thawing.

Plans and specifications

Plans and specifications for installing subsurface drains shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Planning considerations for water quantity and quality

Quantity

1. Effects on the water budget.

2. Effects on baseflow and runoff to water uses and users.

3. Effects on ground water recharge.

4. The volume of soil water needed to improve plant growth.

Quality

1. Effects on the delivery of sediment and dissolved and sediment-attached substances.

2. Effect of changes in the delivery of dissolved salts, such as nitrates, on downstream water uses and users.

3. In areas of ground water recharge, changes in the delivery of dissolved substances to the aquifer.

4. Effect on downstream water temperatures.

5. Effects on the visual quality of downstream water.

Terrace (ft, m)

Definition

An earth embankment, a channel, or a combination ridge and channel constructed across the slope.

Scope

This standard applies to the planning and design of all types of terraces. It does not apply to diversions.

Purpose

To: (1) reduce slope length, (2) reduce erosion, (3) reduce sediment content in runoff water, (4) improve water quality, (5) intercept and conduct surface runoff at a nonerosive velocity to a stable outlet, (6) retain runoff for moisture conservation, (7) prevent gully development, (8) re-form the land surface, (9) improve farmability, or (10) reduce flooding.

Conditions where practice applies

This practice applies where:

1. Water erosion is a problem,
2. There is a need to conserve water,
3. The soils and topography are such that terraces can be constructed and farmed with reasonable effort,
4. A suitable outlet can be provided, or
5. Runoff and sediment can damage land or improvements downstream or impair water quality.

Design criteria

Spacing. The maximum spacing for terraces for erosion control shall be determined by one of the following methods:

1. $V.I. = xs + y$ or $H.I. = (xs + y)\left(\frac{100}{s}\right)$

Where:

$V.I.$ = vertical interval in ft (m)
$H.I.$ = horizontal interval in ft (m) (see figures 1 and 2)
x = a variable with values from 0.4 to 0.8 (0.12 to 0.24)
s = land slope in percent
y = a variable with values from 1.0 to 4.0 (0.3 to 1.2)

Values of x for different geographical zones are shown in figure 4. Values of y are influenced by soil erodibility, cropping system, and crop management practices. A value of 1.0 (0.3) shall be selected for erodible soils with tillage systems that provide little or no cover during periods of intense rainfall. A value of 4.0 (1.2) shall be used for erosion-resistant soils with tillage systems that leave a large amount of cover (1.5 tons of straw equivalent per acre or 3.4 metric tons per hectare) on the surface. A value of 2.5 (0.75) shall be used if one of the factors indicated is favorable and the other unfavorable. Other values between 1.0 (0.3) and 4.0 (1.2) may be used according to the estimated quality of the factors. The horizontal spacing does not have to be less than 90 ft.

2. Universal soil loss equation (USLE). The spacing shall not exceed the slope length determined by using the allowable soil loss, the most intensive use planned, the expected level of management, and the terrace P factor (table 1).

In no case shall the maximum horizontal spacing exceed that shown in table 2 for the conditions shown. The maximum limits may not be exceeded when making the adjustments indicated below. Spacing may be increased as much as 10 percent to provide better alinement or location, to adjust for farm machinery, or to reach a satisfactory outlet. Spacing may be increased an additional 10 percent for terraces with underground outlets. The spacing shall be adjusted to provide for an even number of trips for anticipated row crop equipment and maximum opportunity for changing row widths. The likelihood of benching of steep slopes by tillage, land forming, and erosion shall be considered when determining the terrace interval.

For level terraces used for erosion control and water conservation, the spacing shall be determined as indicated earlier, but the maximum horizontal spacing shall not exceed 600 ft (180 m). An x value of 0.8 (0.24) may be used for all level terraces used primarily to impound water. Figures 1 and 2 show the horizontal interval or erosion length to be used in calculating terrace spacing (figure 3).

For terraces on noncropland, the maximum spacing shall be governed by the capacity requirement.

Table 1.—Terrace P factors

Horizontal interval (ft)	Horizontal interval (m)	Closed outlets[1]	Open outlets, with percent grade of[2] 0.1-0.3	0.4-0.7	0.8
Less than 110	Less than 33	0.5	0.6	0.7	1.0
110-140	33-42	0.6	0.7	0.8	1.0
140-180	43-54	0.7	0.8	0.9	1.0
180-225	55-68	0.8	0.8	0.9	1.0
225-300	68-90	0.9	0.9	1.0	1.0
More than 300	More than 90	1.0	1.0	1.0	1.0

NOTE: If contouring or stripcropping P factors are appropriate, they can be multiplied by the terrace P factor for the composite P factor.

[1]"P" factors for closed outlet terraces also apply to terraces with underground outlets and to level terraces with open outlets.
[2]The channel grade is measured on the 300 ft of terrace or the one-third of total terrace length closest to the outlet, whichever distance is less.

Table 2.—Maximum horizontal spacing for terraces

Slope	USLE R factor of 0-35		35-175		More than 175		With contour stripcropping		For concentrated flow control	
Percent	*ft*	*m*	*ft*	*m*	*ft*	*m*	*ft*	*m*	*ft*	*m*
0-2	700	210	500	150	450	130	600	180	700	210
2-4	700	210	400	120	300	90	600	180	700	210
4-6	600	180	400	120	200	60	600	180	600	180
6-9	400	120	300	90	150	45	400	120	500	150
9-12	400	120	250	75	150	45	250	75	500	150
12-18	250	75	200	60	150	45	150	45	400	120
More than 18	250	75	200	60	150	45	150	45	300	90
Minimum spacing required, all slopes	200	60	150	45	90	27	90	27	200	60

Alinement. Terraces shall be parallel if feasible and as parallel as practicable. Curves shall be long and gentle to accommodate farm machinery. Land forming, extra cut or fill along the terrace line, multiple outlets, variations in grade, channel blocks, and other methods shall be used to achieve good alinement.

Field efficiency may be used to compare alternative terrace systems. Field efficiency is the ratio of time required to farm the field being planned, to that required to farm a rectangular field of the same acreage ½ mi long.

Capacity. The terrace shall have enough capacity to control the runoff from a 10-year frequency, 24-hour storm without overtopping. For terraces with underground outlets, the capacity shall be increased by the estimated 10-year sediment accumulation, unless provisions are made to maintain the design capacity through maintenance. Terrace systems designed to provide flood protection or to function with other structures shall have adequate capacity to control a storm of a frequency consistent with the potential hazard. When the capacity is determined by the formula $Q = AV$ and the V is calculated by using Manning's formula, an n value of 0.06 shall be used for bare channels; and SCS-TP-61, Handbook of Channel Design for Soil and Water Conservation, or equivalent, shall be used for vegetated channels.

Cross section. The terrace cross section shall be proportioned to fit the land slope, the crops grown, and the farm machinery used. Additional height shall be added if necessary to provide for settlement, channel sediment deposits, ridge erosion, the effect of normal tillage operations, and safety. The ridge shall have a minimum width of 3 ft (1 m) at the design elevation. The minimum slope of a vegetated front or back ridge slope is 2:1. If necessary, steeper slopes may be used for special purposes but must be stable. The opening at the outlet end of gradient and open-end level terraces shall have a cross section equal to that specified for the terrace channel.

End closures. Level terraces may have open ends, partial end closures, or complete end closures. Partial and complete end closures shall be used only on soils and slopes where the stored water will be absorbed by the soil without appreciable crop damage or where underground outlets are provided.

Figure 1

Horizontal Interval for Steep Back-Slope Terraces

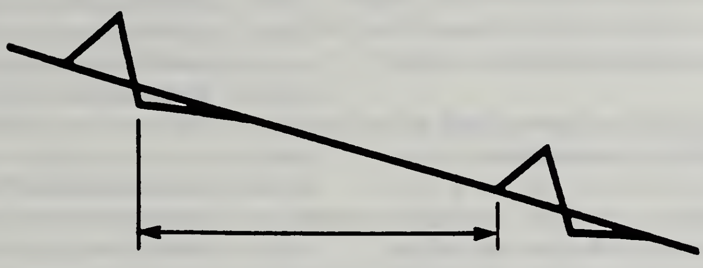


Figure 2

Horizontal Interval for Broad-Based Terraces

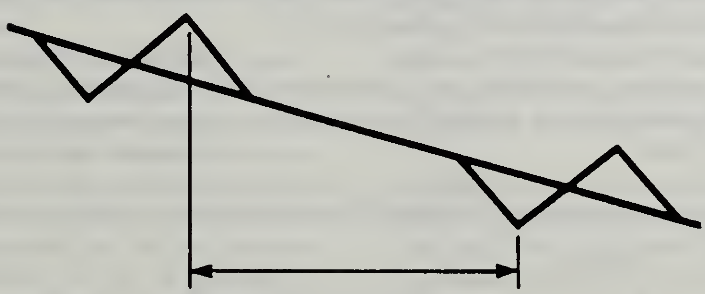
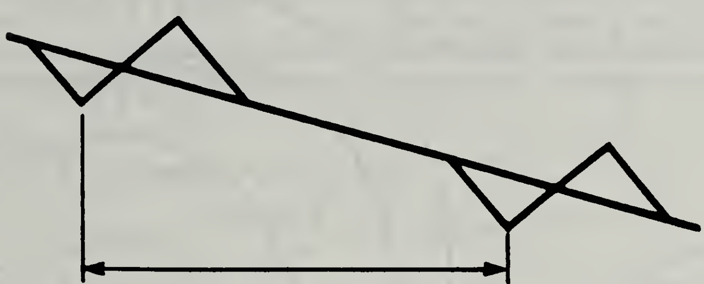


Figure 3

Terrace Spacing



If terraces with closed or partly closed ends are specified, the end closures must be installed before the terraces are completed. The end closures shall be designed so that the water flows over the end closure before overtopping the terrace ridge.

Partial end closures shall not be more than half the effective height of the terrace ridge. Complete end closures are more than half the height of the ridge. The cross section of the closures may be less than the terrace cross section.

Channel grade. Channel grade shall be determined by one of the following methods:

1. Maximum channel grade in the lower reaches of the channel shall not exceed 0.6 percent.
2. Maximum channel velocity for farmed channels shall be nonerosive for the soil and planned treatment. Maximum velocity for erosion-resistant soils is 2.5 ft/s (0.75 m/s); for average soils, 2.0 ft/s (0.6 m/s); and for easily erodible soils, 1.5 ft/s (0.45 m/s). Maximum velocity for Hawaii shall be 5.5 ft/s (1.65 m/s). Velocity shall be computed by Manning's formula, using an *n* value of 0.035.
3. Maximum channel velocities for permanently vegetated channels shall not exceed those used for grassed waterways.

Channel grades may be uniform or variable. Channel velocity shall not exceed that which is nonerosive for the soil and planned treatment. For short distances and in upper reaches, channel grades or velocities may be increased to improve alinement. If terraces have an underground outlet, water and sediment will pond in the channel, thus reducing the velocity and allowing steeper channel grades near the outlet. Minimum grades shall be such that ponding in the channel because of minor irregularities will not cause serious damage to crops or delay field operations.

Terrace length. The volume of water stored in level terraces is proportional to the length. Therefore, it is necessary that the length be held within reason so that damage in case of a break is minimized. Level terrace length shall not exceed 3,500 ft (1,000 m) unless the channel is blocked at intervals not exceeding 3,500 ft (1,000 m). Normally, the gradient terrace length is controlled by the capacity and the nonerosive velocity requirements.

Outlets. All terraces must have adequate outlets.

Vegetated outlets may be used for gradient or open-end level terraces. Such an outlet may be a grassed waterway or a vegetated area. The outlet

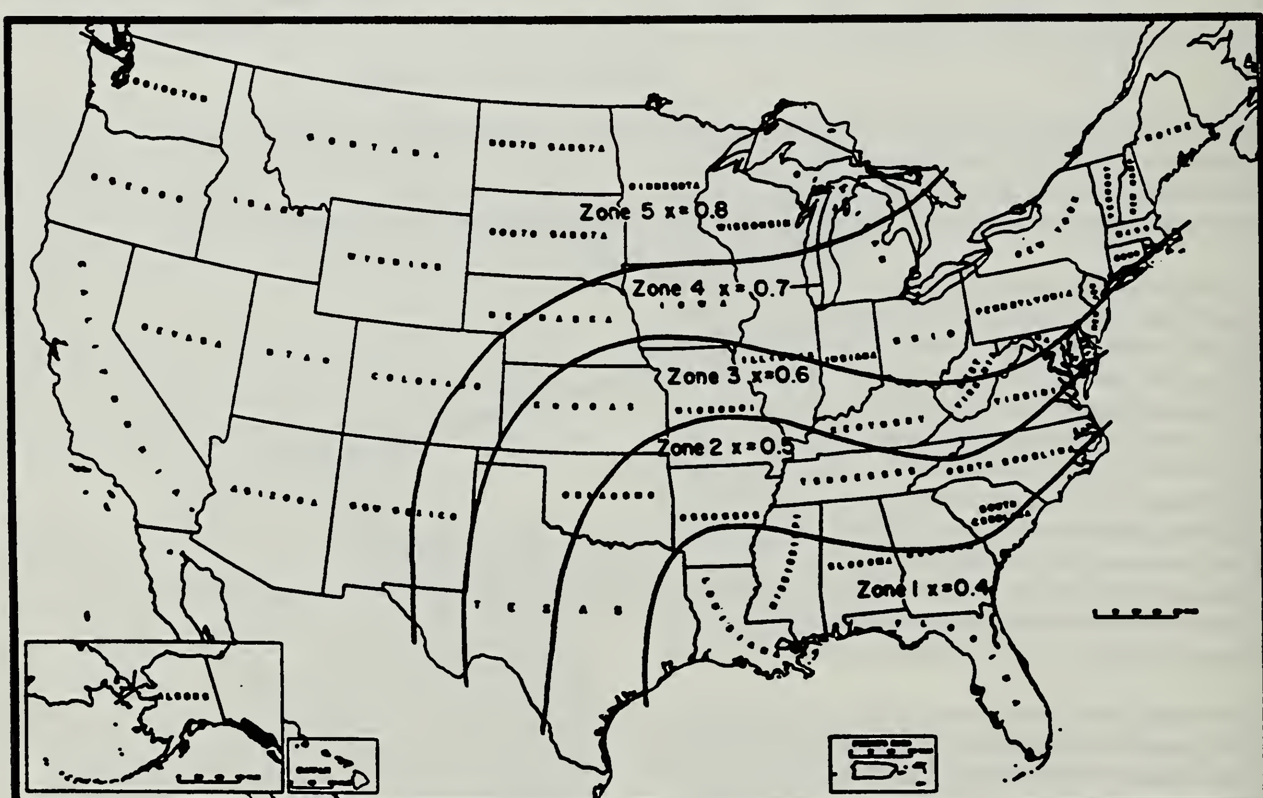


Figure 4—Values of *x* in equation $V.I. = xs + y$ or $H.I. = (xs + y)(100/s)$.

must convey runoff water to a point where the outflow will not cause damage. Outlets shall be installed and vegetated before the terrace is constructed if necessary to provide a stable nonerodible outlet or to insure establishment of vegetative cover. The water surface in the terrace shall not be lower than the water surface in the outlet at their junction when both are operating at design flow.

Underground outlets may be used on gradient or level terraces. The outlet consists of an intake and an underground conduit. An orifice plate, increase in conduit size, or other features shall be installed as needed to control the release rate and prevent excessive pressure when more than one terrace discharges into the same conduit. The discharge, when combined with the storage, shall be such that a 10-year-frequency, 24-hour storm will not overtop the terrace, and growing crops will not be damaged significantly by standing water. The release time shall not exceed 48 hours for the design storm. Shorter periods may be necessary for some crops, depending on soil characteristics and water tolerance of crops to be grown.

The underground conduit shall meet the requirements specified for underground outlets (620) or for subsurface drains (606). Conduits must be installed deep enough to prevent damage from tillage equipment. The inlet shall consist of a vertical perforated pipe of a material suitable for the intended purpose. The inlet shall be located uphill of the front slope of the terrace ridge, if farmed, to permit passage of farm machinery and, if necessary, provide for the anticipated accumulation of sediment and subsequent raising of the terrace ridge. The outlet of the conduit shall have adequate capacity for the design flow without causing erosion. Blind inlets may be used where they are effective, usually in well-drained soils.

Soil infiltration may be used as the outlet for level terraces. Soil infiltration must permit drainage of the design storm from the terrace channel within a reasonable period so that crops are not significantly damaged by standing water.

Combinations of different types of outlets may be used on the same system to maximize water conservation and to provide for economical installation of a more farmable system.

Safety and maintenance

A program shall be established for maintaining terrace capacity, storage, ridge height, and outlets. Each inlet for underground outlets must be kept clean and sediment buildup redistributed so that the inlet is in the lowest place. Inlets damaged or cut off by farm machinery must be replaced or repaired immediately.

Terrace ridges, especially those with steep back slopes, can be very hazardous. For this reason, some farmers prefer steep front slopes, thus keeping machinery away from the steep back slopes. All cut and fill slopes that are to be farmed must be no steeper than those on which farm equipment can operate safely. Any hazards must be brought to the attention of the responsible person.

Vegetation. All areas to be vegetated shall be established to grass as soon as practicable after construction. The sod shall be maintained and trees and brush controlled by chemical or mechanical means.

Plans and specifications

Plans and specifications for installing terraces shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Planning considerations for water quantity and quality

Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation and ground water recharge.

2. Variability effects caused by seasonal or climatic changes.

3. The type of outlet, time of water detention, topography, and geology of the site.

4. Effects of snow catch and melt on water budget components.

5. Potential for a change in plant growth and transpiration because of changes in the volume of soil water.

6. Effects on the downstream flows or aquifers that could affect other water uses and users.

7. The effect on the water table suitable rooting depth for anticipated land uses.

8. Potential for water management to supply alternate uses.

Quality

1. Effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that would be carried by runoff.

2. Effects of nutrients and pesticides on surface and ground water quality.

3. Effects on the visual quality of onsite and downstream water.

4. Short-term and construction-related effects on the quality of onsite and downstream water.

5. Potential for development of saline seeps or other salinity problems resulting from increased infiltration in soils that have restrictive layers.

6. Potential for uncovering or redistributing toxic materials such as saline soils.

7. Effects on the movement of dissolved substances below the root zone and to the ground water.

8. Effects on wetlands and water related wildlife habitats.

C. Guide For Selecting Conservation Practices

The following tables identify conservation practices that affect ground and surface water concerns for irrigated and nonirrigated cropland.. Others have been prepared, but are not included with this material, for pastureland, rangeland, forest land, and built-up areas. Practices are displayed in two categories: (1) those that should favorably affect water resources, and (2) those that may unfavorably affect water resources.

1. *Nonirrigated cropland:* Ground water concerns—QUALITY
2. *Nonirrigated cropland:* Ground water concerns—QUANTITY
3. *Nonirrigated cropland:* Surface water concerns—QUALITY
4. *Irrigated cropland:* Ground water concerns—QUALITY
5. *Irrigated cropland:* Ground water concerns—QUANTITY
6. *Irrigated cropland:* Surface water concerns—QUALITY
7. *Irrigated cropland:* Surface water concerns—QUANTITY

These national perspective tables can be used as references when Resource Management Systems are developed or selected for any of the landuses. The tables incorporate information from the "landuse and management effects" tables and the "conservation practice effects" text and tables provided elsewhere. These tables are used as the first level of screening for the selection of practices for more detailed consideration. More detailed consideration must be given to local or site specific resource factors during the selection process, such as rainfall, crops and soil.

Identifying which conservation practices favorably or unfavorably affect water resources is based on the pollution delivery process (availability, detachment, and transport). This process is affected by the water budget, the chemical budget, and entrapment of the pollutant. Judgment, computer-model simulations, and available research were used to assess the movement of pollutants from agricultural land with each practice. Water is the driving force in the pollutant delivery process, and its presence or absence is a key consideration in determining conservation practice effects. In addition, the amount, type, and timing of chemical applications greatly influence their pollution potential and the effects of conservation practices.

Pollution from agricultural chemicals is a water quality concern associated with all landuses. The storage, handling, and disposal of agricultural chemicals pose a special hazard. Producers should be referred to label recommendations, local regulations, and guidelines for proper handling, application, and disposal.

Table 1. *Nonirrigated cropland:* Ground water concerns—QUALITY

Processes	Causes	Practices that should favorably affect ground water	Practices that may unfavorably affect ground water
		Nutrients—Nitrogen	
Leaching of nitrogen below the root zone. Water percolating below the root zone.	Nitrogen in excess of plant needs in the root zone.	Nutrient management. Conservation cropping sequence. Cover and green manure crops. Waste utilization. Grasses and legumes in rotation. Water table control. Structure for water control. Regulating water in drainage systems. Surface drainage. Subsurface drainage.	Terraces. Conservation tillage. Chiseling and subsoiling. Water and sediment control basin. Mulching. Vertical drain. Hillside ditch. Rock barrier. Crop residue use. Stripcropping. Stubble mulching. Grade stabilization structure.
		Pesticides	
Leaching of pesticides below the root zone. Water percolating below the root zone.	Excess pesticide applied. Leachable pesticides. Persistent pesticides. Improper pesticide application or timing.	Pesticide management. Conservation cropping sequence. Cover and green manure crop. Grasses and legumes in rotation. Surface drainage. Subsurface drainage. Structure for water control. Regulating water in drainage systems.	Terraces. Conservation tillage. Chiseling and subsoiling. Water and sediment control basin. Mulching. Vertical drain. Hillside ditch. Rock barrier. Crop residue use. Stripcropping. Stubble mulching. Grade stabilization structure.
		Organic matter and bacteria	
Enters aquifer through fractures, sinkholes, and solution channels. Most prevalent on karst topography.	Over-application of waste. Application on unsuitable sites. Improper timing of waste application.	Waste utilization. Conservation cropping sequence. Cover and green manure crop. Crop residue use. Filter strips.	Vertical drain.

Table 1. ***Nonirrigated cropland:*** **Ground water concerns—QUALITY** (Continued)

Processes	Causes	Practices that should favorably affect ground water	Practices that may unfavorably affect ground water
		Minerals or salinity	
Natural process. Leaching of minerals and salt concentrations.	Naturally occurring. Excess water moving downward from human activity of concentrating water or changing evapotranspiration.	Waste utilization. Conservation cropping sequence. Soil salinity management. Toxic salt reduction. Subsurface drainage (interceptor subsurface drains).	Terraces. Conservation tillage. Chiseling and subsoiling. Water and sediment control basin. Mulching. Vertical drain. Hillside drain. Rock barrier. Crop residue use. Stripcropping.
		Sediment	
Enters aquifer through fractures, sinkholes, and solution channels. Most prevalent in karst topography.	Soil erosion. (geographical area limited).	Crop residue use. Filter strips. Cover and green manure crop. Conservation cropping sequence. Grasses and legumes in rotation. *and* Other appropriate erosion control practices.	Vertical drain.

Table 2. *Nonirrigated cropland:* Ground water concerns—QUANTITY

Processes	Causes	Practices that should favorably affect ground water	Practices that may unfavorably affect ground water
Lack of water available to plants			
Inadequate water in root zone to meet plant needs.	Plow pans restrict downward movement of roots and limit root zone. Plow pans restrict downward movement of water. Bare or compacted soil surface decreases infiltration. Uncontrolled or excess drainage in some soils.*	Terraces. Conservation tillage. Chiseling and subsoiling. Water and sediment control basin. Mulching. Structure for water control.* Water table control.* Regulating water in drainage systems.* Crop residue use. Contour farming. Rock barrier. Stripcropping. Stubble mulching.	Conservation cropping sequence. Cover and green manure crop.
Lack of water available to aquifer			
Decreased infiltration. Excess drainage.*	Plow pans limit downward movement of water. Bare or compacted surface soil will increase runoff. Uncontrolled drains.*	Terraces. Conservation tillage. Chiseling and subsoiling. Water and sediment control basin. Mulching. Structure for water control.* Water table control.* Regulating water in drainage systems.* Crop residue use. Contour farming. Rock barrier. Stripcropping.	Conservation cropping sequence.** Cover and green manure crop.**
Excess water in root zone			
Increased water infiltration. Poor drainage.	Single-season crops remove only a portion of available moisture. Surface conditions to increase infiltration. Inadequate surface or subsurface drainage.	Cover and green manure crops. Conservation cropping sequence. Land smoothing. Precision land forming. Subsurface drainage. Surface drainage. Water table control. Regulating water in drainage systems. Structure for water control.	Terraces. Conservation tillage. Chiseling and subsoiling. Water and sediment control basin. Mulching. Vertical drain. Hillside ditch. Rock barrier. Crop residue use. Stripcropping.

* Where drainage practices already exist.

** Practice increases evapotranspiration from the root zone. Increased infiltration in fields with low residue may offset evapotranspiration under certain precipitation patterns and not reduce available water in the root zone.

Table 3. *Nonirrigated cropland:* Surface water concerns—QUALITY

Processes	Causes	Practices that should favorably affect surface water	Practices that may unfavorably affect surface water
		Nutrients —Nitrogen	
Runoff of soluble nitrogen in water. Movement of nitrogen combined with soil and organic matter from site in water.	Excess surface-applied nitrogen (all sources). Runoff water and interflow. Erosion of soil and organic waste.	Nutrient management. Waste utilization. Structure for water control.* Regulating water in drainage systems.* Water table control.* Filter strips. Cover and green manure crops. Contour farming. Chiseling and subsoiling. Conservation cropping sequence. Conservation tillage. Crop residue use. Grade stabilization. structure. Sediment basin. Stripcropping. Terrace. Hillside ditch. Water and sediment control basin. Grasses and legumes in rotation. Field borders. Stubble mulching. Rock barrier.	Land clearing. Precision land forming. Subsurface drain.** Surface drainage.** Channel vegetation.*** Grassed waterways. ***
		Nutrients—Phosphorus	
Runoff of soluble phosphorus in water. Movement of phosphorus combined with soil and organic matter from site in water.	Excess surface-applied phosphorus (all sources). Runoff water and interflow. Erosion of soil and organic waste.	Same as above.	Same as above.

Table 3. *Nonirrigated cropland:* Surface water concerns—QUALITY (Continued)

Processes	Causes	Practices that should favorably affect surface water	Practices that may unfavorably affect surface water
Pesticides			
Runoff of soluble pesticides in water. Movement of pesticides combined with soil and organic matter from site in water.	Excess pesticide applied. Pesticides with affinity for soil and organic matter. Persistent pesticides. Runoff water and interflow. Improper pesticide application and/or timing.	Pesticide management. Erosion control practices from nutrient concerns above. Water table management practices from nutrient concerns above.	Land clearing. Precision land forming. Subsurface drain.** Surface drainage.** Channel vegetation.*** Grassed waterway. ***
Organic matter and bacteria			
Movement of organic waste, bacteria, and organic matter combined with soil from the site in water.	Over-application of waste. Application on unsuitable sites. Improper timing of waste application. Storm and snowmelt runoff.	Waste utilization. Appropriate erosion control practices. Appropriate water table management practices.	
Minerals or salinity			
Natural process. Movement of organic waste. Sheet flow from surface and interflow from ground water as influenced by human activities.	Naturally occurring. Over-application of waste with high salinity content. Movement of minerals and salt concentrations in soil from the site by precipitation runoff and interflow (saline seeps).	Waste utilization. Toxic salt reduction. Soil salinity management. Conservation cropping sequence. Subsurface drain (interceptor subsurface drain). Regulating water in drainage systems.	Chiseling and subsoiling. Surface drainage. Subsurface drain.
Sediment			
Soil movement in water or by wind.	Precipitation runoff. Wind. Unprotected soil moving into the water courses.	Appropriate wind and water erosion control practices.	Land clearing. Access roads. Clearing and snagging.

* Where surface drainage and subsurface drain practices exist.
** Where water table control or regulating water in drainage systems practices are not applied.
*** Chemical maintenance of vegetation may adversely affect quality of runoff water.

Table 4. *Irrigated cropland:* Ground water concerns—QUALITY

Processes	Causes	Practices that should favorably affect ground water	Practices that may unfavorably affect ground water
		Nutrients — Nitrogen	
Leaching of nitrogen.	Nitrogen in excess of plant needs in the root zone. Excess irrigation water application beyond the root zone capacity. Faulty well or pump hardware. Improperly constructed well.	Nutrient management. Waste utilization. Conservation cropping sequence. Cover and green manure crop. Irrigation water management. Irrigation water conveyance. Appropriate irrigation system & associated practices. Precision land forming. Well. Water table control. Structure for water control. Regulating water in drainage systems. Subsurface drain. Surface drainage.	Terrace. Conservation tillage. Chiseling and subsoiling. Water and sediment. control basin. Mulching. Vertical drain. Irrigation canal or lateral.* Irrigation field ditch.* Hillside ditch. Rock barrier. Crop residue use. Stripcropping.
		Pesticides	
Leaching of pesticides.	Excess pesticide applied. Leachable pesticides. Persistent pesticides. Excess irrigation water. Improper pesticide or irrigation application timing. Faulty well or pump hardware. Improperly constructed well.	Pesticide management. Irrigation water management. Irrigation water conveyance. Appropriate irrigation system and associated practices. Conservation cropping sequence. Cover and green manure crop. Precision land forming. Well. Water table control. Structure for water control. Subsurface drain. Surface drainage.	Same as above.

Table 4. *Irrigated cropland:* Ground water concerns—QUALITY (Continued)

Processes	Causes	Practices that should favorably affect ground water	Practices that may unfavorably affect ground water
		Organic matter and bacteria	
Enters aquifer through fractures, sinkholes, and solution channels. Most prevalent in karst topography. Enters through macropores.	Over-application of waste. Application on unsuitable sites. Excess irrigation water application. Improper timing of waste application and irrigation water.	Waste utilization. Irrigation water management. Appropriate irrigation system & associated practices. Conservation cropping sequence. Filter strip. Cover and green manure crop. Well.	Vertical drains.
		Minerals or salinity	
Natural process. Leaching of minerals or salt concentrations.	Naturally occurring. Excess water moving downward from human activity of concentrating water or changing evapo-transpiration. Irrigation water contains high concentration of dissolved solids.	Waste utilization. Toxic salt reduction. Conservation cropping sequence. Subsurface drain. Irrigation water management. Irrigation water conveyance. Appropriate irrigation system and associated practices.	Terrace. Conservation tillage. Chiseling and subsoiling. Water and sediment control basin. Mulching. Irrigation canal or lateral.* Irrigation field ditch.* Vertical drain.
		Sediment	
Enters aquifer through fractures, sinkholes, and solution channels. Most prevalent in karst topography. Enters through macropores.	Soil erosion (geographical area limited).	Crop residue use. Irrigation water management. Appropriate irrigation system and associated practices. Filter strips. Cover and green manure crop. Conservation cropping sequence. Grasses and legumes in rotation. Other appropriate erosion control practices.	Vertical drains.

* Where canal lateral, or field ditch conveys drainage or tailwater, or where fertilizer is added to the irrigation supply.

Table 5. *Irrigated cropland:* Ground water concerns—QUANTITY

Processes	Causes	Practices that should favorably affect ground water	Practices that may unfavorably affect ground water
Lack of water available to plants			
Inadequate water in root zone to meet plant needs.	Plow pans restrict downward movement of roots and limit root zone. Plow pans limit the downward movement of water. Bare or compacted soil surface decreases infiltration. Uncontrolled or excess drainage in some soils.*	Terraces. Irrigation water management. Appropriate irrigation system and associated practices. Conservation tillage. Chiseling and subsoiling. Water and sediment control basin. Mulching. Structure for water control.* Water table control.* Regulating water in drainage systems.* Crop residue use. Contour farming. Rock barrier. Stripcropping.	Conservation cropping sequence.** Cover and green manure crop.**
Lack of water available to aquifer			
Water that would normally move to the aquifer is removed or its deep percolation is impeded.	Plow pans limit downward movement of water. Bare or compacted surface soil will decrease infiltration. Uncontrolled or excess drainage removes water before deep percolation to aquifer occurs. Increased evapotranspiration.	Irrigation water management. Appropriate irrigation system and associated practices. Terrace. Conservation tillage. Chiseling and subsoiling. Water and sediment control basin. Mulching. Structure for water control.* Water table control.* Regulating water in drainage system.* Crop residue use. Contour farming. Rock barrier. Stripcropping.	Conservation cropping sequence.** Cover and green manure crop.**

Table 5. *Irrigated cropland:* Ground water concerns—QUANTITY (Continued)

Processes	Causes	Practices that should favorably affect ground water	Practices that may unfavorably affect ground water
		Excess water in root zone	
Water in the root zone exceeds plant needs to point of impeding plant growth.	Single-season crops remove only a portion of available moisture. Surface conditions increase infiltration. Inadequate surface or subsurface drainage. Over-application of irrigation water.	Irrigation water management. Irrigation water conveyance. Appropriate irrigation system and associated practices. Cover and green manure crop. Conservation cropping sequence. Land smoothing. Precision land forming. Subsurface drainage. Surface drainage. Water table control. Regulating water in drainage systems. Structure for water control.	Terrace. Conservation tillage. Chiseling and subsoiling. Water and sediment control basin. Mulching. Irrigation canal or lateral. Irrigation field ditch.

* Where drainage practices already exist.

** Practice increases evapotranspiration from the root zone. Increased infiltration in fields with low residue may offset evapotranspiration under certain precipitation patterns and not reduce available water in the root zone.

Table 6. *Irrigated cropland:* Surface water concerns—QUALITY

Processes	Causes	Practices that should favorably affect surface water	Practices that may unfavorably affect surface water
Nutrients — Nitrogen			
Runoff of soluble nitrogen in water. Movement of nitrogen combined with soil and organic matter from site.	Excess surface-applied nitrogen (all sources). Runoff water and interflow. Improperly managed irrigation system. Erosion of soil and organic waste.	Nutrient management. Waste utilization. Irrigation water management. Irrigation system, tailwater recovery. Irrigation land leveling. Appropriate irrigation system. Water table control.* Structure for water control.* Regulating water in drainage systems.* Field border. Cover and green manure crop. Waste utilization. Chiseling and subsoiling. Conservation cropping sequence. Conservation tillage. Crop residue use. Grade stabilization structure. Water and sediment control basin. Terrace. Hillside ditch. Grasses and legumes in rotation. Sediment basin. Filter strips. Contour farming. Stripcropping. Rock barrier.	Land clearing. Surface drainage.** Subsurface drain.** Channel vegetation.*** Grassed waterway.***
Nutrients—Phosphorus			
Runoff of soluble phosphorus in water. Movement of phosphorus combined with soil and organic matter from site.	Excess surface-applied phosphorus (all sources). Runoff water and interflow. Improperly operated irrigation system. Erosion of soil and organic waste.	Same as nitrogen.	Same as nitrogen.

Table 6. *Irrigated cropland:* Surface water concerns—QUALITY (Continued)

Processes	Causes	Practices that should favorably affect surface water	Practices that may unfavorably affect surface water
Pesticides			
Runoff of soluble pesticides in water. Movement of pesticides combined with soil and organic matter from site.	Excess pesticide applied. Pesticides with affinity for soil and organic matter. Persistent pesticides. Runoff water and interflow. Excess irrigation water. Improper pesticide application or irrigation timing.	Pesticide management. Irrigation water management. Irrigation systems, tailwater recovery. Irrigation land leveling. Appropriate irrigation system. Erosion control practices listed for nutrient concerns above. Structure for water control.* Water table control.* Regulating water in drainage system.*	Land clearing. Surface drainage.** Subsurface drain.** Channel vegetation.*** Grassed waterway.***
Organic matter and bacteria			
Movement of organic waste, bacteria, and organic matter in soil from the site. Excess irrigation water.	Over-application of waste or irrigation water. Application on unsuitable sites. Improper timing of waste or irrigation application. Storm and snowmelt runoff.	Waste utilization. Irrigation water management. Appropriate irrigation system. Filter strips and other appropriate erosion control practices. Appropriate water table management practices.	Land clearing. Surface drainage.** Subsurface drain.**
Minerals or salinity			
Natural process. Movement (surface runoff and interflow) of dissolved minerals and salts from soil and organic waste by irrigation or storm water.	Naturally occurring. High content of minerals and salt concentration in soil and underlying geology. Excess irrigation water. Over-application of waste with high salt content.	Waste utilization. Toxic salt reduction. Irrigation water management. Irrigation water conveyance. Appropriate irrigation system. Conservation cropping sequence. Subsurface drainage (interceptor subsurface drains). Regulating water in drainage systems.*	Land clearing. Surface drainage.** Subsurface drain.**

Table 6. ***Irrigated cropland:*** **Ground water concerns—QUALITY** (Continued)

Processes	Causes	Practices that should favorably affect surface water	Practices that may unfavorably affect surface water
		Sediment	
Soil movement.	Irrigation water applied at erosive rate. Water and wind erosion.	Water and sediment control basins. Irrigation water management. Appropriate irrigation system and associated practices. Appropriate wind and water erosion control practices.	Land clearing. Access roads.

* Where drainage practices already exist.

** Where water table control or regulating water in drainage systems practices are not applied.

*** Chemical maintenance of vegetation may adversely affect the quality of runoff water.

Table 7. *Irrigated cropland:* Surface water concerns—QUANTITY

Processes	Causes	Practices that should favorably affect surface water	Practices that may unfavorably affect surface water
		Depletion of surface water	
Excessive withdrawals for irrigation.**	Excess irrigation water applied. Excess loss in the conveyance system. High evapotranspiration crops. Irrigated acreage larger than water supply.	Irrigation water management. Irrigation water conveyance. Appropriate irrigation system and associated component practices. Conservation tillage. Contour farming. Chiseling and subsoiling. Crop residue use. Terrace. Hillside ditches. Rock barriers. Stripcropping. Water table control.* Structure for water control.* Regulating water in drainage systems.* Water and sediment control basin. Conservation cropping sequence.	Irrigation canal or lateral. Irrigation field ditch.

* Where drainage practices already exist.

** Withdrawals at a rate that exceeds evapotranspiration plus minor system and application losses.

D. Effects of Conservation Practices On Water Quantity and Quality

The "Practice Effects" material contains a synopsis of current knowledge of effects of conservation practices on surface and ground water quantity and quality. The information as compiled from literature searches, interviews with scientists and engineers, and computer model runs. Climate, soil, geology, and management influence performance of conservation practices and must always be considered in the decision making process.

The Contents and selected pages from the document are included on the following pages. The complete document is available separately.

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EFFECTS OF CONSERVATION PRACTICES ON WATER QUANTITY AND QUALITY

Introduction

This is an interim reference which contains the current knowledge of the effects of conservation practices on surface and ground water quantity and quality. Agency and academic scientists are presently researching how these practices affect water quantity and quality. This document is necessarily interim because our knowledge and understanding of the functions of these practices and their short and long term effects is rapidly expanding.

Much of the data have been obtained from existing publications by SCS, ARS, Cooperative Extension Service, and USEPA. They were obtained from a literature search and analysis by the USDA-Extension Service at the National Water Quality Evaluation Project at North Carolina State University. Other data have been obtained by interviews with scientists and engineers associated with universities and research centers throughout the nation. Other parts of these data were obtained by the interaction and consultation of national leaders of the SCS in the natural science and engineering fields. These consultations and reviews have been coordinated through the National Field Office Technical Guide Committee.

This document presents a national overview of the effects of conservation practices on water resources. Some of the data quantitatively define the actions of some of the commonly used practices on the water budget and the yields of sediment and sediment attached and dissolved substances. These data are the result of experimental and modeling experiences throughout the nation. Effects that occur from all the different climates or geological terrains are not included. This means that effects described in the tables of this document may be correct in a general, national sense but might lead to conclusions that are wrong for local combinations of climate and terrain.

Local climatic, soil, management and geologic conditions must always be considered in considering the effects of conservation practices on water resources. Water quality effects of conservation practices, defined on a local basis by research or modeling, better define the effects of the practices within that area. SCS offices should use these results of local studies and analyses in reference material for their Field Office Technical Guide (FOTG) to aid them in conservation planning.

Practices in these tables deal only with the agriculturally related practices. Conservation practices that apply to mine land reclamation have not yet been included, although there are long-term plans for their evaluation.

Grassed Waterway (acre) 412	This practice is used either to stabilize an active gully or serves as a stable outlet channel for contouring, contour stripcropping, diversions, terraces, rock barriers, water control structures, hillside ditches, and underground outlets. Since they are usually installed in areas of concentrated flow, their effect on the quantity of ground and surface water is minor. There may be a slight reduction in the peak discharge from the drainage area.	This practice may reduce the erosion in a concentrated flow area, such as in a gully or in ephemeral gullies. This may result in the reduction of sediment and substances delivered to the receiving waters. Vegetation may act as a filter in removing some of the sediment delivered to the waterway, although this is not the primary function of a grassed waterway. Any chemicals applied to the waterway in the course of treatment of the adjacent cropland may wash directly into the surface waters in the case where there is a runoff event shortly after spraying. When used as a stable outlet for another practice, waterways may increase the likelihood of dissolved and suspended pollutants being transported to surface waters when these pollutants are delivered to the waterway.
Grade Stabilization Structure (No.) 410	This practice may contribute to ground water recharge due to ponding and under certain geologic conditions. Soil water in the vicinity of the structure may increase and stimulate plant growth and transpiration. Generally with full flow nondetention structures, very little change would be expected.	Where reduced stream velocities occur upstream and downstream from the structure, streambank and streambed erosion will be reduced. This will decrease the yield of sediment and sediment-attached substances. Structures that trap sediment will improve downstream water quality. The sediment yield change will be a function of the sediment yield to the structure, reservoir trap efficiency and of velocities of released water. Ground water recharge may affect aquifer quality depending on the quality of the recharging water. If the stored water contains only sediment and chemicals with low water solubility, the ground water quality should not be affected. Impounding water may cause or aggravate a soil or water salinity problem.

Practice	WATER QUANTITY	WATER QUALITY
Conservation Cropping Sequence (acre) 328	This practice reduces erosion by improving soil tilth. Soil tilth increases the soil's ability to absorb and hold rainfall in the root zone. With the reduction of surface runoff, the quantity of surface water available is reduced. However, in humid areas, precipitation during nongrowing seasons or in excess of the crop needs and in excess of the soil's water holding capacity during the growing season may percolate into the ground water. Underlying soil layers, rock and unconsolidated parent material may enhance, delay or block the delivery of the percolate to ground-water aquifers. The ultimate fate of deep percolation will be site specific, depending on the soil and geologic conditions.	This practice reduces erosion by increasing organic matter, resulting in a reduction of delivery of sediment and associated pollutants to surface waters. Crop rotations that improve soil tilth may also disrupt disease, insect and weed reproduction cycles, reducing the need for pesticides. This removes or reduces the availability of some pollutants in the watershed. Deep percolation may carry soluble nutrients and pesticides to the ground water. Underlying soil layers, rock and unconsolidated parent material may block, delay, or enhance the delivery these pollutants to ground water. The fate of these pollutants will be site specific, depending on the crop management, the soil, and geologic conditions.
Conservation Tillage (acre) 329	This practice increases infiltration and decreases runoff. It may reduce peak flows from the field and extend the time of base flow in the nearby streams. There may be reduced evaporation which may result in increased percolation to the ground water.	This practice reduces soil erosion, detachment and sediment transport by providing soil cover during critical times in the cropping cycle. Surface residues reduce soil compaction from raindrops, preventing soil sealing and increasing infiltration. This action may increase the leaching of agricultural chemicals into the ground water. In order to maintain the crop residue on the surface it is difficult to incorporate fertilizers and pesticides. This may increase the amount of these chemicals in the runoff and cause more surface water pollution. The additional organic material on the surface may increase the bacterial action on and near the soil surface. This may tie-up and then breakdown many pesticides which are surface-applied, resulting in less pesticide leaving the field. This practice is more effective in humid regions. With a no-till operation the only soil disturbance is the planter shoe and the compaction from the wheels. The surface-applied fertilizers and chemicals are not incorporated and often are not in direct contact with the soil surface. This condition may result in a high surface runoff of pollutants (nutrients and pesticides). Macropores develop under a no-till system. They permit deep percolation and the transmittal of pollutants, both soluble and in le to be

	WATER QUANTITY	WATER QUALITY
		carried into the deeper soil horizons and into the ground water. Reduced tillage systems disrupt or break down the macropores, incidentally incorporate some the materials applied to the soil surface, and reduce the effects of wheeltrack compaction. The results are less runoff and less pollutants in the runoff.
Contour Farming (acre) 330	Contour farming may reduce the rate and the amount of runoff. This may increase the amount of soil moisture until the soil profile becomes saturated. The amount of percolate may increase, which may increase the amount of ground-water recharge.	This practice reduces erosion and sediment production. Less sediment and related pollutants may be transported to the receiving waters. Increased infiltration may increase the transportation potential for soluble substances to the ground water.

Section IV – Planning Process

A. Field Office Technical Guides

Most activities carried out by SCS Field Offices (FO), in conjunction with local Conservation Districts, are based upon technical information and data. All conservation planning and application requires SCS conservationists and district employees to provide landowners, land users, and others with localized technical information.

Technical guides are primary technical references for SCS and districts. They contain technical information about conservation of soil, water, and related plant and animal resources. Field Office Technical Guides are localized so that they specifically apply to the geographic area for which they are prepared.

Technical guides provide: a. interpretation of resource use and potential productivity. b. information for achieving land user's objectives, c. information for interdisciplinary planning for the conservation of soil, water, and related resources, d. criteria to evaluate the quality of resource management systems, e. standards and specifications for conservation practices, f. information for evaluating the economic feasibility of conservation practices and resource systems.

Technical Guides contain the following five sections:

Section I - General Resource References

This section lists references and other information used in the FO area for making decisions about resource use and management systems. These references include maps, erosion prediction methodology and data, and climatic data.

Section II - Soil and Site Information

Soils are described and interpreted. Soil characteristic that limit or affect land use and management are identified, and soils are rated according to limitations, capability, suitability, and/or potential. Interpretations are specific to the soils identified and mapped int the area

Detailed soil interpretations include: cropland interpretations, range and native pasture interpretations, forest land interpretations, non- agricultural interpretations, recreation, wildlife, pastureland, hayland, mined land, windbreak, engineering, and waste disposal interpretations.

Section III - Resource Management Systems (RMS)

This section provides guidance for developing RMS's and describes their acceptable levels of quality. An RMS is a combination of conservation practices and management associated with a primary use of land or water.

There are six categories of resource concerns which an RMS must address. The categories and erosion control, water disposal, animal wastes and agri-chemical management, resource management, water management, and off-site effects.

Section IV - Practice Standards and Specifications

This section describes standards and specifications for all conservation practices used in the field office. Practice standards establish the minimum level of acceptable quality for planning, designing, installing, operating, and maintaining conservation practices. Specifications describe requirements necessary to install a practice so that it functions properly. Specifications include major elements of work to be done; kind, quality, and quantity of materials to be used; and essential details of installation.

Section V - Economic Data

This section contains prices paid for items used in agricultural production, prices received for commodities produced,cost of owning and operating farm machinery, costs of installing and maintaining practices, typical crop budgets and economic evaluation methods.

B. Planning in Response To Water Quality Concerns

This section reviews the 10 elements of planning and implementation from the SCS National Conservation Planning Manual and identifies where each part of this document fits into the planning process.

Water quality concerns that should be considered in the conservation planning process include agricultural nonpoint source contaminants. These are:

Sediment. Any farming practice that disturbs soil creates an erosion hazard. The resulting sediment that moves to water bodies or water courses may degrade water quality and quantity. Sediment in suspension reduces the amount of sunlight available to aquatic plants, covers fish spawning beds, and clogs the gills of fish. It fills drainage ditches, stream channels, and reservoirs. It can increase water treatment costs and reduce the value of water for recreation. In addition, sediment can be a carrier of other contaminants when sediment-attached substances are transported into surface water.

Nutrients. Nutrients from all sources are of concern in the preparation of a resource management plan. Nutrients from commercial fertilizer, animal wastes, or those originating from green manure crops or other cropping practices must all be considered. Nutrients, especially nitrogen and phosphorus, can cause excess pond and lake enrichment, kill fish with high ammonia concentrations, and impair water for drinking or recreation. High concentrations of nitrate in drinking water can be toxic. Nitrogen in the nitrate form is highly mobile and can be leached through the root zone to the water table. Phosphorus and other substances attached to soil particles may be transported into surface water with sediment.

Animal waste. Waste is one of the foremost nonpoint pollution concerns. Wastes can originate from large feedlots with concentrations of cattle, or hog, poultry, or even rabbit production operations. Animal wastes can contribute pathogens to water, decrease fish population, make water unattractive and unsafe for recreation, decrease oxygen levels, and increase the cost of water treatment.

Pesticides. Some estimates place pesticide use at more than one billion pounds annually. Some pesticides are immediately toxic to fish and aquatic plants while others may transfer in food chains and create long-term effects on fish and wildlife.

Salinity. Salinity is a natural condition that can be accelerated or lessened by recommended cultural and conservation practices. Salinity often becomes a serious problem in irrigated areas as a result of the concentrating effect.

Salinity reduces plant growth and yields, causes corrosion of pumps and pipes, increases the cost of water treatment, and can harm fish and plants.

Water Quantity. Water quantity is also a concern in many areas. Where irrigation is essential and supplemental irrigation is used, the management of water to maintain sufficient supplies is essential. The 10 planning elements below follow a logical series of steps, some of which may be carried on concurrently or repeated.

1. Providing Information

The water-related material being added to the FOTG will enable field office personnel to provide information to local decision-makers and the public about the status of water quality and quantity. Information and local regulations and permitting requirements must also be provided as applicable.

Landowners and operators involved in agriculture need to be made aware of local concerns and potential hazards. This information will provide a basis for informing local publics.

> For example, Robeson County, North Carolina, is located in the Upper Coastal Plain, Major Land Resource Area (MLRA) 133. The FOTG identifies a Cretaceous aquifer underlying part of MLRA 133.
>
> The dominant soils of the area are sandy and rapidly permeable. The aquifer is a significant local source of water, but has a high potential for nutrient and pesticide infiltration from agricultural sources. This type of information must be provided to local officials and decisionmakers.

2. Requesting Assistance

Landowners, operators, and public officials will not request assistance until they have enough information to recognize they have a problem or need, and that the problem or need can be solved or met with assistance from SCS and other sources. An information campaign, therefore, is needed to inform people of local conditions. The goal of the information effort is to stimulate people to ask, “What can I do?” or “What needs to be done?”

> In Robeson County, for example, farmers, public officials, and other concerned publics need to know the significance of the Cretaceous aquifer as it relates to the local water supply. The potential hazard for nutrient and pesticide infiltration from farming and urban uses must be explained. The goal of this information effort would be to prompt people to request information and guidance on the use of nutrients and pesticides.

3. Determining Objectives

Although most landowners and operators are interested in improving their operation, reducing expenses, and increasing net profits, more and more are becoming interested in knowing how their operation may influence the quality of local water sources and public health. Landowner and agency objectives, considered together, define the target for formulating and selecting RMS’s. Field office personnel can help people understand how management and conservation practices influence water quality.

In the case of Robeson County, operators must be informed of the Cretaceous aquifer, its condition, and any potential effects that their farming operation and management may have on the local water quality and supply. This may not directly change an operator's objective, but it may change the RMS selected to meet a desired objective.

4. Providing Resource Inventory Data

Based on the water quality and quantity data contained in the FOTG, resource data must be provided to operators during the planning process. Some data, such as soils information, are already available for use in conservation planning.

Specific types of data that can be provided with reference to ground water include:

1. The existence of critical aquifers.
2. Aquifer condition.
3. Potential hazard of nutrient and pesticide contamination.
4. Organic waste hazards.
5. Salinity.
6. Other agricultural chemical pollution. (Cleaning compounds, fuels, oils, chemical containers, etc.)

The condition and potential hazard to surface waters must also be assessed. Potential threats to surface water include:

1. Nutrient enrichment by nitrate or phosphate.
2. Pesticide contamination.
3. Organic matter enrichment.
4. Bacteria contamination.
5. Sediment volumes.
6. Increased salinity.
7. Other agricultural chemical pollution.

In Robeson County, specific resource data contained in the local FOTG related to the Cretaceous aquifer and soils needs to be provided to farm operators. These data include the location of the aquifer in relation to the farm or field location. Also, data concerning soil types that would allow infiltration of pesticides and nutrients and their location on the farm. Information concerning the mobility of fertilizers can be provided from section II, "Soil Rating for Nitrates."

The "Pesticide Data Base" in section I and "Soil-Pesticide Interactions Interpretations" in section II can provide information on the mobility and persistence of pesticides being used.

5. Interpreting, Analyzing, and Evaluating Resource Inventory Data

Just as the planner has interpreted, analyzed, and evaluated data related to soil conditions and erosion, he or she must now evaluate water resource conditions and data related to geology, fertilizers, and pesticides. Assessment of resource data, land use, and management provides insight on the impact or effect the operation has on resource conditions. When the existing condition does not meet the landowner's objectives or standards of quality, a change in operations must be considered. The resource assessment must include the identification of resource capabilities and limitations.

> In Robeson County, each operator's management of the land must be assessed to determine their potential effect on ground water quality. The type of tillage, land use, crops grown, form and amount of fertilization and the form and application method of pesticides must be analyzed to determine the effect on water reaching the aquifer. Existing management and conservation practices must be assessed to determine how they affect the infiltration of water to the aquifer.

6. Developing and Evaluating Conservation Alternatives

RMS's must be evaluated to determine how they affect local water resource conditions and quality.

The planner, when working with a producer, will use local RMS's and develop alternatives for consideration. Development of alternatives involves formulating various combinations of practices which will meet producer objectives and solve or minimize the water quality and/or quantity problems within the capability of the resources available. To aid a producer in selecting an alternative, the suggested actions and anticipated outcome needs to be presented for consideration. A comparison of the producer's present situation with expected results of a suggested alternative provides the effects (i.e. advantages and disadvantages) of a particular alternative. Effects can me monetary and nonmonetary. Tradeoffs in terms of positive and negative effects will be faced by the producer.

> When considering RMS's in Robeson County, over the Cretaceous aquifer, the planner must take into account the potential problems of high erosion and nutrient and pesticide pollution. Erosion control practices that may be considered are conservation tillage (excluding use of continuous no-till), crop residue use, grassed waterways, grade stabilization structures, conservation cropping sequence, or any other practice that will reduce erosion while not significantly increasing infiltration. Erosion control practices such as sediment basins and terraces are not acceptable because they may increase infiltration. Practices that address nutrient and pesticide concerns include nutrient management, pesticide management, cover crops or conservation cropping sequence. Any practice that decreases the amount of chemicals applied or increases plant use of fertilizers and water available for percolation would have positive effects.

7. Making decisions

Operators need to be guided to select RMS's that maintain or improve local resources. Where water quality or quantity are already degraded because of agricultural activities, selected RMS's should contribute to improved conditions.

Decisions will be easier if suggested RMS alternatives are presented in a way that clearly shows clear plus and minus effects.

> Producers in Robeson County make decisions by comparing the advantages and disadvantages of alternative actions. Advantages and disadvantages may be monetary or nonmonetary. Planners assist in decisionmaking by providing information, but only the producer can weigh these monetary and nonmonetary values and make the decisions.

8. Documenting decisions.

When an alternative has been selected, a description of the actions that a producer needs to take must be recorded. Copies of decisions will be kept in the case file and appropriate guide sheets will be provided to producers.

> The decisions documented in Robeson County may contain pesticide and nutrient management. Because this may be new to the producers, guide sheets on applying or handling pesticides, calibrating sprayers, or safely disposing of chemical containers should be provided. This information may be available from the Extension Service or chemical suppliers.

9. Implementing Decisions

Planners have new references and tools to assist landowners implement practices that favorably effect water quality. A water resource supplement to practice standards has been added for each practice in section IV of the FOTG, and two new practices have been added.

Extension Service and pesticide consultants can assist the producer in implementing the pesticide management parts of a plan. The application of some practices in a plan may not start for years. If there is a long delay, operation, maintenance, and management of practices must be reviewed with operators before implementation.

> Clients in Robeson County, as they apply practices, may need additional information from SCS, consultants, or Extension specialists. During application the effects of each practice must be further evaluated to insure that conditions have not changed and the beneficial effects will still be realized.

10. Evaluating and Updating

Both producers and field office personnel should evaluate practices to assess their effects on water quality. Detailed evaluations requiring water quality monitoring, soil testing, or plant testing may have to be done by someone other than field office staff. Field office staff should continually seek additional local resource information. As planners gain water quality planning experience and knowledge, they should work with producers to revise and update plans, repeating the steps in the process as needed in each case.

> During the application process reevaluation of resource conditions may be needed. As additional information becomes available producers in Robeson County may evaluate additional alternatives and revise their plans.

Glossary

Ai. Active ingredient.

Absorb. To take up or receive by chemical or molecular action.

Adsorb. To gather a gas, liquid, or dissolved substance on a surface.

Aquifer. A sand, gravel, or rock formation capable of storing or conveying water below the surface of the land.

Available nutrient. That portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

Baseflow. The stream discharge composed of ground water drainage and delayed surface drainage.

Bed load. The sediment that moves by sliding, rolling, or bouncing on or near the streambed.

Bedrock. Unbroken solid rock, overlain in most places by soil or rock fragments.

Coliform bacteria. A group of bacteria that mostly inhabits the intestinal tract of humans and animals, but also found in soil. While harmless in themselves, coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms. See fecal coliform bacteria.

Cone of depression. A depression in the water table produced by the extraction of water from a well.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of residue on the surface throughout the year.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Crop root zone. The depth of soil penetrated by plant roots.

Deep percolation. The downward movement of water through the soil below the crop root zone.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Diversion. A ridge of earth, generally built across the slope, to protect downslope areas by diverting runoff water from its natural course.

Drainage. (1) Removal of excess surface or ground water from land by surface or subsurface drains. (2) Soil characteristics that affect natural drainage.

Effluent. The discharge of a pollutant, or pollutants, in a liquid form from a containing space.

Ephemeral. Lasting a very short time.

Ephemeral stream. A stream or portion of a stream that flows only in direct response to precipitation, and receives little or no water from springs or a continuous supply from snow or other sources. Its channel is at all times above the water table. See intermittent stream.

Eutrophication. The natural or artificial process of nutrient enrichment whereby a water body becomes filled with aquatic plants and low in oxygen content.

Eutrophic lake. A lake that has a high level of plant nutrients, a high level of biological productivity, and low oxygen content.

Evapotranspiration. The loss of water from an area by evaporation from the soil and plant surfaces and by transpiration from plants.

FOTG. Field Office Technical Guide. FOTG's are primarily technical references for SCS. They contain technical information about conservation of soil, water, and related plant and animal resources. Technical guides are localized so that they specifically apply to the geographic area in which they are used.

Fecal coliform bacteria. That portion of the coliform group of bacteria originating in the intestinal tract of warm-blooded animals, including man; an indicator of the possible presence of pathogenic organisms.

Field capacity; field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after it has been thoroughly soaked and allowed to drain freely; the field moisture content 2 or 3 days after a soaking rain.

Filter strip. A strip or area of vegetation which slows runoff or wastewater, allowing sediment, organic matter, and other pollutants to be removed from the flow.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to erosion-resistant grasses, used to conduct surface water from or through cropland.

Grazing capacity. The maximum stocking rate possible without inducing damage to vegetation, water, or related resources.

Ground water. The subsurface water supply in the saturated zone below the level of the water table.

Gully. A channel resulting from erosion and caused by the concentrated flow of water during or immediately following heavy rains. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage. (A rill is of lesser depth and can be smoothed by ordinary tillage.)

Half-life. The time required for one-half of a specified substance to degrade or become inert.

Herbicides. Chemicals used to kill undesirable vegetation.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of the soil bare of vegetation to permit infiltration. Soils are assigned to four groups; soils in Group A have a high infiltration rate when thoroughly wet and a low runoff potential; soils in Group D are at the opposite extreme.

Infiltration. The downward entry of water into the soil. This is distinct from percolation, which is movement of water through soil layers or material.

Interflow. That portion of rainfall that infiltrates into the soil and moves laterally through the upper soil horizons until intercepted by a stream channel or until it returns to the surface at some point downslop from its point of infiltration.

Intermittent stream. A stream or portion of a stream that is dry for a large part of the year, ordinarily more than 3 months. See ephemeral stream.

Irrigation efficiency. The amount of water stored in the crop root zone compared with the amount of irrigation water applied.

Irrigation return flow. Surface and subsurface water which leaves the field following the application of irrigation water.

Karst. Topography characterized by depressions without external drainage; sinkholes; underground caverns; solution channels.

Koc. A measurement of the index for soil sorption, or the tendency of pesticides to be attached, by chemical or physical bonds, to soil particle surfaces.

Labile. Unstable; apt to change.

Leachate. Liquids that have percolated through a soil and that carry substances in solution or suspension.

Loading; mass loading. Quantity of a substance entering the receiving waters.

MLRA. See Major Land Resource Area.

Macropore. A pore or soil void larger than about 0.075mm (e.g, worm holes, shrinkage cracks, root channels).

Major Land Resource Area. An area of land reasonably alike in its relationship to agriculture with emphasis on intensities of problems in soil and water conservation; ordinarily larger than a land resource unit and smaller than a land resource region.

Mass loading. See loading.

Mounding. A rise in water table elevation resulting from man's activities.

Nonpoint source pollution. Pollution arising from an ill-defined and diffuse source, such as runoff from cultivated fields, grazing land, or urban areas.

No till; zero till. Planting a crop without prior seedbed preparation into sod, crop residue, or an existing cover crop and eliminating subsequent tillage operations.

Nutrients. Fertilizer, particularly phosphorus and nitrogen– the two most common components that run off in sediment.

Overstocking. Placing a number of animals on a given area that will result in overuse of plant resources at the end of the planned grazing period.

Pathogens. Disease-causing organisms.

Persistence time. The time required for a pesticide to become inert. Arbitrarily assumed to equal four half-lives when measured persistence time not available.

Pesticide. A chemical substance used to kill or control pests such as weeds, insects, fungus, mites, algae, rodents, and other undesirable agents.

Planner. The final responsibility for resource management planning decisions must be made by the individual who owns or controls the land, so he or she is the real "planner." In this material, however, "planner" refers to the agency representative or consultant assisting the land user. This avoids the use and repetition of long titles.

Point source pollution. Pollution arising from a well-defined origin, such as a discharge from an industrial plant or runoff from a beef cattle feedlot.

Postemergence. Application of chemicals, fertilizers, or other materials along with the operations associated with crop production after the crop has emerged through the soil surface.

RCN. See Runoff Curve Number.

RMS. See Resource Management Systems.

Receiving waters. All distinct bodies of water that receive runoff such as streams, rivers, ponds, lakes, and estuaries. Also, all navigable surface waters and, in certain instances, ground water, if there is a direct connection.

Resource Management Systems. (RMS) An RMS is a combination of conservation practices and management techniques identified by the primary use of the land or water. Under an RMS, the resource base is protected by meeting acceptable soil losses, maintaining acceptable water quality, and maintaining acceptable ecological and management levels for the selected area.

Root zone; rooting zone. The depth of soil penetrated by crop roots.

Runoff. That portion of precipitation or irrigation water that flows off a field and enters surface streams or water bodies. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground water seepage interflow.

Runoff curve number (RCN). The SCS procedure for estimating direct runoff. The RCN represents an index value that expresses the runoff potential from a watershed based on a combination of soils (hydrologic soil group) and a land use treatment class (cover). The runoff curve number shows the relative value of the hydrologic soil/cover complexes in producing direct runoff.

SWQMA. State Water Quality Management Agency.

Saline seep. Area of recently developed salinity concentration on nonirrigated land where salty ground water moves to the surface and crop or grass production is reduced or eliminated.

Salinity. The concentration of dissolved solids or salt in water.

Sediment. The solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth's surface, either above or below sea level.

Sediment yield. The quantity of sediment arriving at a specific location.

Seepage. Percolation of water through the soil from unlined canals, ditches, laterals, watercourses, or water storage facilities.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Soil sorption index. The capability of chemicals to absorb into or adsorb to soil or organic particles; measured by the Koc value.

Sorb. To take up and hold either by absorption or adsorption.

Sorption. The binding of one substance to another either by absorption or adsorption.

Stage discharge. A relationship that provides water surface elevation (usually in feet) and the rate of flow or discharge capacity (usually in cubic feet per second).

Stripcropping. Growing crops in alternating strips or bands that provide vegetative barriers to wind and water erosion.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches. Also called the plow layer.

Tailwater. The runoff of irrigated water from the lower end of an irrigated field.

Terrace. An embankment or ridge constructed on the contour or at a slight angle to the contour across sloping soils. Runoff water intercepted by the terrace soaks into the soil or flows slowly to a prepared outlet.

USLE. Universal Soil Loss Equation. A method of estimating the average soil loss from sheet and rill erosion that might be expected to occur over an extended period of time under specified conditions of soils, slope, vegetation, climate, cultural operations, and conservation measures.

Visual quality. A rating or estimate of the uniqueness or desirability of a visual resource.

Volatization. Loss of a substance through evaporation or sublimation. When manure is spread on a field, ammonia-nitrogen in the manure may volatilize quickly and be lost as a fertilizer unless it is plowed under.

Water budget. The relationship, or equation, which describes the balance and movement of water within soil, plants, and atmosphere.

Wilting point. The moisture content of a soil, on an ovendry basis, at which a plant wilts so much that it does not recover when placed in a humid, dark chamber.

Direction of Groundwater Movement

Human induced impacts on groundwater

Natural processes

Soil Conservation Service
U.S. Department of Agriculture